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MECHANICAL ENGINEERING

January 1929

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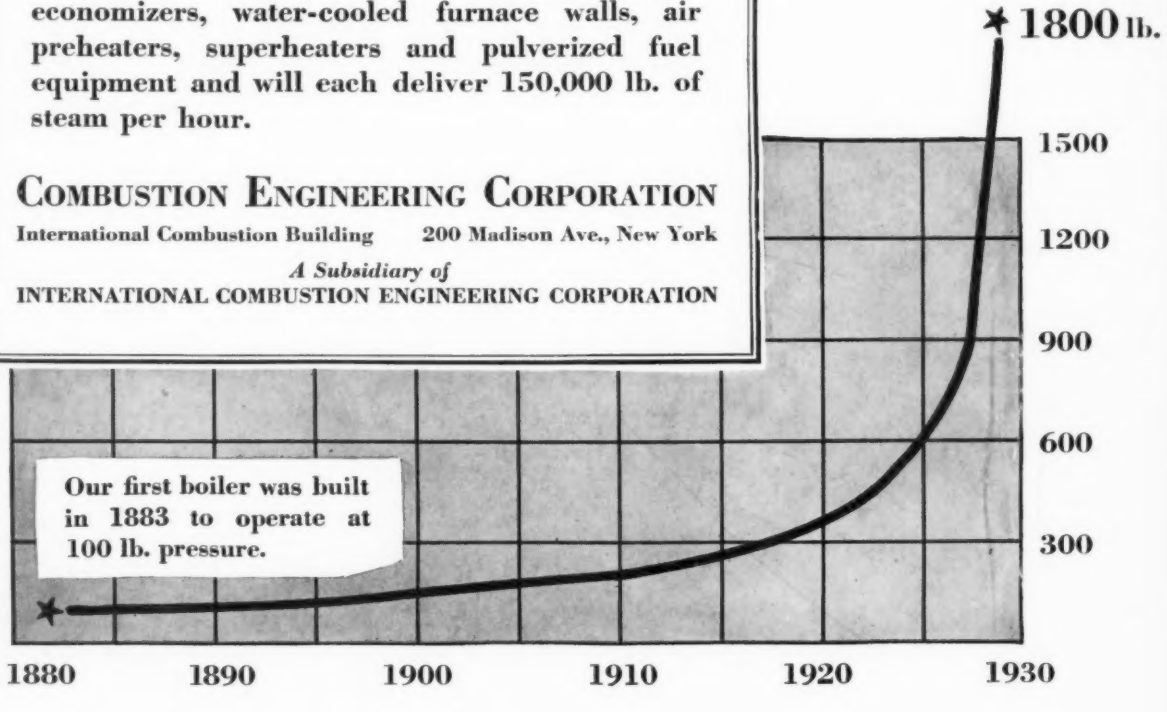

COMBUSTION ENGINEERING

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To New A.S.M.E. Members

IF YOU young men were my sons, I would say to you that you have joined a society that stands for everything that is upright and honorable. Live your life and pursue your profession as becomes a dignified and honorable member of this great organization. If you want to get along well in life, to make friends and to have the happiness that every man who lives a successful life deserves, then I would say the most important thing for you to cultivate and to guard is integrity and loyalty to your fellow-members. Stand by those with whom you are associated. Whatever the cost may be, live a life whose great underlying principles are honor, honesty, and loyalty.

There is nothing that will bring you such recompense as loyalty—loyalty to those with whom you are associated, loyalty to the man for whom you work, loyalty to those connected with you in business, loyalty to your organization, The American Society of Mechanical Engineers, and loyalty to this great country of ours.

CHARLES M. SCHWAB.

(From charge to new members at the Annual Dinner of the A.S.M.E., December 5, 1928.)

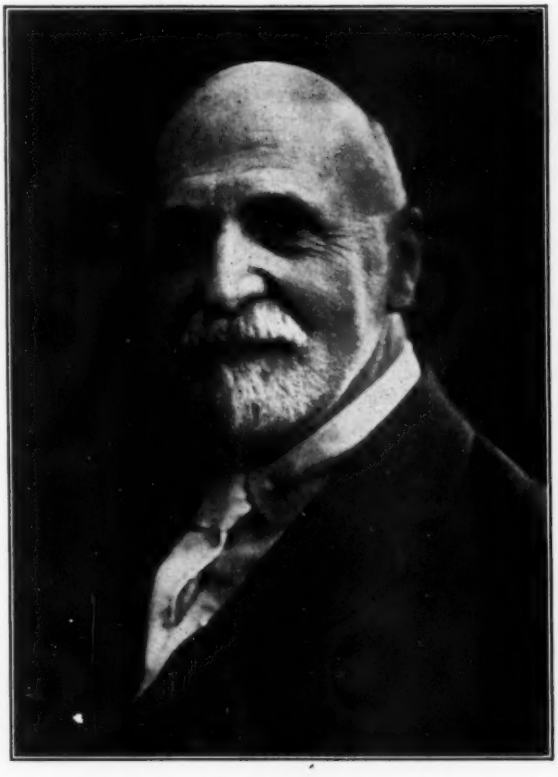
MECHANICAL ENGINEERING

Volume 51 January, 1929 No. 1

Consistency[1]

By ALEX DOW, DETROIT, MICH.

TRADITION and precedent require that I shall make a Presidential Address, wherefore this effort. Tradition and precedent demand that the Presidential Address shall be of the nature of a message to the Membership—a deliverance ex cathedra, wise in content and literary in form. The making of such an address is for me no customary exercise of the wits and the language given me by Providence, or acquired from environment. As a distributed credit or debit between Providence and environment, the responsibility for that equipment of mine is about fifty-fifty. The wits, such as they are, apparently came from Providence by the path of heredity. Environment supplied the language—and left permanent marks upon it.



ALEX DOW

The peculiar perversity of the present moment is that I have no honest-to-goodness message for you. This semblance of a message should be classified as make-believe. In each make-believe there must needs be a certain grain of reality—otherwise it would entirely lack verisimilitude. From this present make-believe you may therefore cull such particles as seem to be realities, and relegate the remainder to the limbo provided for forgotten fairy tales.

The same remainder, although it is by assumption make-believe, is not of necessity untruthful. It may even be consistent. That word "consistent" has pestered me of late. I have listened to talk of consistent statistics, of consistent policies, of consistent behavior, of consistent merit, until the word begins to rub a sore spot into my hide. Not a big sore spot—just such as one occasionally acquires at an inconvenient locus. My choice of an inconvenient locus is directly under the tip of my right shoulder blade. Yours probably is somewhere else, but as a preferred location of consistent inaccessibility I present to your judgment the tip of the right shoulder blade as meriting the blue ribbon.

This impingement of an overfrequent word upon my mentality is no new experience. Many years ago when welfare (by implication, welfare of employees as a duty of employers) was much talked about, I developed a cantankerous hostility to the word "welfare." Looking backward from this remote era, I realize that what offended me was but little the overwork of a good word, and was very much indeed the superfluity of talk about good work done. My personal code required me (and still does) when there should be an opportunity to be helpful to a fellow-mortal, to be helpful as and when the circumstances permitted, to thank God for the opportunity, and thereafter to hold my peace. There is less noise nowadays and more welfare.

Another word which irritated that right shoulder blade was "efficiency." There was so much palaver about efficiency as a generality rather than as a local entity clearly definable, that I found myself sympathizing with the railroad-yard roustabout who named his mule "Efficiency," sometimes adding thereto as a momentarily opprobrious epithet the word "Engineer." That mule always did want to do things differently from other mules. The merit of his differentiations was not apparent. In the circumstances of time and place and as a mule he probably earned the title.

Still one other word has recently been ruffling me, which word is "research." It makes no amelioration of my irritation that the word be accented on the first syllable instead of on the second—and if it continues to be an irritant, I think I shall move to substitute some compound phrase such as "technical investigation" for the irritating two syllables. What I shall then call those who are now by title Junior Research Engineers remains to be seen—or heard. It may not be tactful.

The word "consistency" is not yet classified by me as an irritant. I am minded to help save it from misuse—to limit its application to the useful quality which it signifies by dictionary definition. That quality is

> . . . . a state of compatibility and harmony between things that can exist in the same system—or of operations and agencies that are controlled by one aim and therefore do not neutralize one another.

[1] Presidential Address at the Annual Meeting, New York, N. Y., December 3 to 7, 1928, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

A most meritorious quality forsooth, and two excellent and consistent definitions! Observe that consistency is not a synonym for conformity nor congruity nor changelessness. The vital words in the definition appear to me to be those which recognize the control of purpose *by one aim*. And such seriousness as there is in this talk is directed toward the redemption of a good word from misuse, and to the praise of a truly valuable quality.

I asked one of the most helpful ladies in the world to find for me somewhere in Shakespeare's works the quotation, "Consistency, thou are a jewel," and in due course my friend informed me that Shakespeare did not say so but that some one unknown, in a ballad of a date long after Shakespeare, ended a quatrain with the line "consistencie's a jewell." In my own efforts to authenticate that quotation I fell over the statement by Emerson: "A foolish consistency is the hobgoblin of little minds."

There is no conflict between the two authorities. And by assumption there are no little minds in this audience. Little minds do not wilfully expose themselves to presidential addresses. That act implies fortitude—and optimism.

It appears to me that *unity of aim* is the test of appropriateness of use of the studied word. Further, it is the touchstone for the expressed quality in thought or speech or action. And I have come to understand that most misuses of the word and failures to exhibit the quality have their roots in the lack of a well-defined aim, or in a wavering from that aim.

CONSISTENCY: IS IT INBORN OR ACQUIRED?

Query: Before proceeding further, are we born consistent or is consistency (if we have any) an acquired virtue? The alternative question may be rephrased as: Can consistency be acquired in later life? And I think it can be disposed of by saying that a restricted environment may compel consistency, but that the person who has not had in him from childhood some root of consistency will never be consistently consistent. I may also rephrase the first part of the query by asking: Are children born with the virtue of consistency and do they lose it from lack of encouragement in its exercise? To this query my own answer would be "Yes." Every child is a consistent person. He meets existence as something that may expand around him from its original limitation by his mother's arms to the unlimited bounds of a universe, provided that Professor Einstein has left to us our lack of limits and has not in the interim cribbed, cabined, and confined all space around us grown-ups. A child accepts this sequence of expansions and demands that each new fact offered to him shall be consistent with each prior fact. Everything that he learns is forthwith correlated and closed up on the knowledge already stored in his mind. This also holds for principles of conduct. It is absolutely fatal to your respect by a child to let him do something today which you are going to forbid tomorrow and to tolerate the day after. He refuses to accept a divergence of aim, and his sense of justice, resenting his being forbidden to do something that was formerly tolerated, or his being required summarily to do something that was previously omitted—his childish sense of justice makes of him a rebel.

As to facts, the little people are born without skill to differentiate between imagination and what we grownups call reality. They apply the philosophy that we do our true living in our own minds and not in an outer world, and it requires painstaking, patient education to bring them safely to the understanding that this world in which they are initiate required a separation between that which is demonstrable to the senses and that which is imagined.

My own job of education of young people ought to have been finished long ago. The baby of the family is twenty-eight plus. But the turn of the wheel has brought to my home to stay awhile a five-year-old who is just now learning philosophically the differences between fact and fancy. I do not think that it was exactly fair to assign to me a job as instructor. Yet I was successful in establishing with her the stipulation of my own childhood, that when a story began with the prefix "once upon a time" it was a story told merely because it was pleasant to listen to, and not at all as a recital of what grownups would call "observed occurrences." That stipulation made the young lady free of the Just So stories, and of Twilight Land, and Grimm, and the prettier tales of the Arabian Nights. When she thereafter demanded that I discuss fairies and djinns I had to turn my memory back a full sixty years to the days when I myself had a practicable modus vivendi with a certain number of fairies, and a few djinns, and even a casual imp or two, and she and I now share that friendly understanding and are prepared to be properly courteous to visitors of those tribes if and when they shall manifest themselves. That was well done, and I enjoyed the event. But I assumed an attitude of protest when, after certain Sunday School books had introduced her to angels duly depicted with wondrous wings, the young lady insisted that some one inform her *whether* when these angels went to sleep they took off their wings and went to bed or whether they roosted. I do not think I was a proper referee, and indeed I took refuge in the evasion that I did not know. That was a definite disappointment to her, and I explained my lack of knowledge by the statement (which was partially truthful) that the reason I did not know was that when angels undressed they always put me out of the room beforehand. Talk about consistency—why should I be expected to make consistent the vision of golden-winged angels with the nocturnal habits of little ladies or of dicky birds? That was no fair question to ask the President of this Society!

HOW FAR SHALL CONSISTENCY GIVE WAY TO USEFULNESS?

Another query: How far shall consistency give way to use fulness? For illustration let me recall the well-known fact that for many years the Buick motor cars and the Dodge motor cars had a gear shift which was reversed in sequence from the gear shift of all other cars made on this side of the ocean. The gear shift of those two companies was well considered and consistent. It is highly appropriate that the forward motion of the gear-shift lever shall coincide with the forward motion of the car. It is an evidence of superhuman intelligence that the running position of the lever shall take it out of the way of the knee of the driver or of his passenger. In these respects the gear shift which we now accept as standard was and is lacking in true consistency. If the aim of the builders had been to conform their car to their own ideals we should continue indefinitely to be under the necessity of remembering which particular trick we are driving, for it is most awkward, when you want to make a quick start from the line on the change of the signal, to back up and bump the man behind you. But if the true aim were to build an acceptable car for the American public, consistency required the setting aside of the minority fashion, and the change was well made.

And here is a collateral query. Supposing that the Buick and Dodge companies had felt called upon to deny the rightness, the truthfulness, the heaven-born equity of any other arrangement of gating. Supposing that they had announced there would be no departure from conscience; would they have found support? I know that such a thing is a tax upon supposition, but you can try to imagine it. Suppose it had been insisted that there could only be one truly righteous way of gating a gear shift, and that all others were contrary to revelation and the evident intent of Providence that forward motion should coin-

cide with forward motion. Supposing that they had appealed to state legislatures to prohibit the teaching of any way of shifting gears excepting that which required this coincidence. Suppose—Oh! let us quit supposing! The motor industry has been for many years one of the wisest in its acceptance among competitors of those practices which the public found good, and its collective wisdom has made such acceptance a simple and commercially profitable matter. Nevertheless that whimsy of a fundamentalist General Motors Corporation does tickle me.

Query, one time more: How far may a Society like our own expand its assistance to meritorious projects? Our aims are set forth with reasonable conciseness in our Constitution and By-Laws, and these aims are not divergent nor inconsistent. But there is a constant call upon us as a Society to scatter our efforts, to turn our organization to other aims and objects than those on which we are united by definition. Such objects may be praiseworthy. They may tend to save souls, which is ideal; or they may tend to fill hungry mouths on earth, which is practical and much more important. That you may understand how much of a heretic I am, let me declare my fellowship with those mortals who try to do what they can for the world in which we live and move and have our being; and my total lack of sympathy with those others who are concerned about the ordering and magnitude of our mansions in the skies. Let the gods see to the latter! But in the name of consistency, let us say that the unity of aim of this Society is set forth in its Constitution and that concentration thereon is the bond that holds us together! If we are going to take up the work of the church, of the state, or of the municipality, or any part thereof, we shall have to expand our statement of aims and our qualifications for membership until we receive into our Society all men of good intent, and are prepared to act upon any proposal whatever which tends to the betterment of society—and that road leads to disunity and disaster.

ARE OUR METHODS OF EDUCATING ENGINEERS CONSISTENT?

Query: Are our methods of educating engineers consistent? If required to define our aim we discover that our target is not a unity but a diversity. Be it noted that the pupils under education are free agents and that each of them has his own aim and purpose. Possibly this complimentary assumption is not justifiable. I have met engineering pupils who were so obviously without purpose or sign of ultimate utility that I have despaired of their ever being anything more than "chinking." That word has its root in the old-time building of the log cabin when the interstices between logs were stuffed with chips and wet clay, which material was chinking. It was good for nothing else.

Now, you will find in any engineering college two groups who are receiving (Query: are exposed to?) a standard prescription of schooling notwithstanding divergent group purposes. One group, who individually have my hearty sympathy, are young men having a bent for engineering and who must needs educate themselves as quickly as possible to the point where their selected profession may begin to make them a living. The other group are under no such stress. It contains the men who are seeking knowledge for the love of knowledge—the natural investigators of physical phenomena. Likewise it contains the young men whose family or business prospects are of such a nature that an engineering education will be helpful in the furtherment of those prospects. Finally this group contains the few who intentionally seek engineering training as part of a liberal education.

Even if there be no other divergencies of aim, the adoption by most of our schools of a compromise formula for engineering education is inconsistent with the divergent aims of the students, who are there by their own volition and without whom there would be no school. One group requires training toward immediate and profitable usefulness in this rough-and-tumble world which in the main selects its servants by the "hire-and-fire" system. The last year of training of these boys should be as specialized as the training of a polo pony or a steeple chaser or a lady's hack. Some schools provide just that sort of training. The other group of students should have more science and less shop and drafting-room training—more Taussig and less Taylor—and there are schools which fit their needs. Most schools compromise their curricula into inconsistency in the attempt to serve both groups.

To my mind the answer is—separate schools. Let the youngster who must become a useful and productive junior member of the profession at the earliest possible moment—let him choose the school that will turn him out trained to the minute for an awaiting job. Let the other students go to a university where the broad principles of engineering are taught as an incident of a broader teaching of physics—or of natural philosophy, as we used to call it years ago. Thus only may each curriculum have the unity of aim which will make it consistent.

WHEREIN LIES OUR HUMAN NEED OF CONSISTENCY?

Wherein lies our human need of consistency? Is it an evidence of superiority of mankind above the other diversified creatures of God? I think so. If we are to be controlled by intellect, choosing and planning our ways in life, we must insist that each thing decided in our individual lives shall remain decided and not be open to perpetual discussion. Our seeking must be for accomplishment and not for chatter about possible or past accomplishment. Our need is that it shall be so—that having done one thing we shall go on in peace to the doing of the next. We do not desire repetition—far from us be such monotony! But we insist that there shall be continuity by consistency in the rule of life. And we have set up for our chosen worship a divinity "in whom there is no variableness, neither shadow of turning." Amen!

Now to close this talk in a lighter mood; it is not laid upon us that we shall be consistent to the verge of absurdity. That is what Emerson intended when he called consistency the hobgoblin of little minds. The absolutely consistent person can be as much of an impediment or a nuisance as the man with an ingrowing conscience. It is well that this lesson should be learned early in life—it usually is. Once upon a time—please notice the formula—there was a little lad about twice the age of the young lady who recently stumped me with the question as to angelic methods. He had a shock of dark hair on his head—hair too fine to wear well—and he was quick of thought and speech. As is the fashion of eleven-year-olds, ofttimes his speech outran his thought. He was consistent, very much so indeed. Probably he inherited that quality from his grandchildren. I *chose* that word "grandchildren." It was not a slip of the tongue. I ask you why should not a man inherit his qualities from his descendants? I know the descendants have just those qualities, and if time is no more, or if it is looped upon itself like the serpent symbol of eternity, holding its tail in its mouth, why should the qualities of the father be visited upon his children and not vice versa? If it is not so then Einstein is wrong, and I claim thanks. I don't desire to think of space as corded up in a spherical bundle, nor of time as a form of thought.

To go on with the story: This interesting young person was one of a group which in the long winter evenings of the far north must needs amuse themselves indoors, and did so by playing many forgotten games. Of one of these the name was "Forfeits," and in the playing of it one-half of the party was sent out of the room, to be called in again singly and by name and required to execute any one of a hundred traditional tasks for

the amusement of the group which was having its innings. On the evening of my story, the party was large and divided fairly between boys and girls, and the girls had sent the boys out of the room, and my young friend when called in was informed that because of his manifold transgressions the penalty was laid upon him to "Take good regard of this assembly of wit and beauty, and forthwith bow to the wittiest, kneel to the prettiest, and kiss the one you love the best." I have said that the lad had inherited consistency. To him the game was the game and the order was the order. He regarded his laughing judges, and after a minute bowed to the undisputed wittiest of the girls. Her wit had a well-known touch of acid, and the choice brought a ripple of laughter. To select the prettiest required the exercise of judgment, and consistency misled him into kneeling to a certain golden-haired beauty. To this day he still insists that she was the prettiest then and there in the room. The third requirement was simple—he knew the one he loved best, and he turned happily to that one. Did he kiss her? He did not. Instead of the expected upturned cheek he received on his own two cheeks a right-handed and a left-handed buffet from a pair of wicked little hands, and the defiant challenge—"If you think Helen is prettier than I, you can just go and kiss *her*."

Of course there was much laughter and a sadly puzzled boy. Later he told his sorrows to a wise and lovely friend of twice his age, who counseled him, "Laddie, never hint that any one is prettier than your own sweetheart. In sweethearting, flattery goes further than consistency."

The moral must be obvious. Each of you has known eleven-year-old love, and to the gentle memory of that love I now leave you.

The Progress of Japanese Industry

IN VIEW of the fact that a World Engineering Congress will be held next autumn in Tokyo, the following brief survey of the steps by which Japanese trade and industry have been developed since they were first started on a modern basis is of timely interest. As the editorial in *Engineering* of November 9 last from which it is abstracted states, the true value of the Japanese achievement can hardly be appreciated without such an account of its circumstances.

The most remarkable feature of the performance, which would have been sufficiently remarkable without it, is the extraordinary and unprecedented speed with which it has been accomplished. It is now just sixty years since the revolution of 1868 started, among other epoch-making institutions, the industrial development of the country on modern lines. Progress was slow at the outset. By 1885, for instance, less than 350 miles of railway had been laid, but by the end of the century this had increased to nearly 4000 miles, and at the beginning of the present year about 11,500 miles were open to traffic, a further 1300 miles were under construction, and sanction has been given for the construction of 2000 miles more. Nearly 1000 miles are electrified, and nearly 2000 miles more may be so when the lines under construction and sanctioned have been completed. The textile industries, on which the country depends mainly not only for a large part of its home supply but also for the largest part of its material for export, and therefore, incidentally, of its purchasing power for other commodities, have shown remarkable growth. Between 1914 and 1927 the production of raw silk increased sixfold, the number of cotton spindles was doubled, the production of woven fabrics more than doubled, and imports of raw wool have replaced those of part and wholly manufactured woolens to a constantly increasing extent. In the same period the production of refined sugar and the amount of wheat milled have trebled, the production of cement has quadrupled, and of paper other than Japanese-style paper has increased fivefold, while the industry of heavy chemicals has expanded fivefold for some products, such as sulphuric acid, and has extended to others which in 1914 were produced in negligible quantities or not at all. The metal industries have not been growing at the same rate. The production of iron and steel has been limited by inadequate home supplies of ore and coke, and by lack of machinery and sufficient skilled workmen. Japan is only now in the third generation since the introduction of machinery, and only in the last few years has a generation grown up which has been familiar with machinery all its life. Nevertheless, a great variety of machinery has been made, and the volume in particular of electrical machines which has been produced is such as to have caused considerable decreases in imports, notwithstanding that at the same time the use of such machines was growing rapidly. The development of electrical power in the last few years has indeed been remarkable. From a generating capacity of a little over 1,000,000 kw. in 1920, there were over 3,000,000 kw. installed and operating at the end of 1926, and half as much again was under construction, two-thirds of the installed plant being driven by water power.

These examples of the progress that has been made are remarkable enough in themselves, but they are still more striking when it is remembered that they have been made in a period during which the country had its full allowance of other difficulties. During most of 1877, for instance, it was occupied in the Satsuma insurrection. In 1894 and 1895 another twelve months were spent in the war with China, and in 1904 to 1905 another year and a half in the war with Russia. Barely ten years afterward they took their part in the World War, and in 1923 suffered the severe damage of the earthquake. In the last ten years, moreover, the banking system of the country was severely tested by the commercial depression of 1920, following on a period of great prosperity, which began while most other nations were at war. The history of the grave financial difficulties in which the trade of Japan was involved as a consequence of the failure of its banking organization to adjust itself to these circumstances is related in some detail in a report prepared by Messrs. G. B. Sansom and H. A. Macrae, up to the period of the financial crisis which has been the chief event of the last two years. The situation appears now to have been set right, and with surprisingly little apparent effect on Japanese trade, industry, and even external credit. The progress of adjustment has been drastic, involving the elimination of many of the weaker institutions, but in some ways those that survived have become stronger, and in some directions have strengthened themselves further by combination with each other. Generally speaking, the reorganization of industrial finance, though perhaps not altogether completed, seems to have proceeded so far as to furnish a sound foundation for the operation that the further development of industry will require.

At the present time a chief anxiety of Japanese industry is to make itself as far as possible independent of the manufactures of other countries, though taking from them their raw material. Import duties are levied on manufactured or partly manufactured goods, and on these are sufficient to restrict the amount of imports to an extent that tends constantly to decrease their proportion to total consumption. This policy is pursued wherever there is a chance of supplying the demands of the home market by internal manufactures instead of by imports.

Progress and Prospects in Mechanical Engineering

A Review of Recent Accomplishment in Its Various Branches, Prepared by the Professional Divisions of The American Society of Mechanical Engineers

FOREWORD

AUTHORITATIVE statements of advances in many fields of mechanical engineering during the past year have been prepared by experts and are published in the following progress reports of the A.S.M.E. Professional Divisions. These are interesting and impressive documents worthy of serious study and thought by all those who would keep themselves abreast of the times.

Into the preparation of these reports has gone much study, and they represent the combined efforts of many men. The subject-matter has been obtained from numerous representative sources by means of questionnaires sent out by the Divisions with a view to gathering the most pertinent facts for this annual stock-taking of the profession.

The progress reports have become an established feature of the Annual Meeting of the Society. They represent one of the contributions which the Professional Divisions make to the Society and to the engineering world. They reflect the growth and development of the profession and point the way to further advances in the future. By means of them the prestige of the Society is enhanced.

The gratitude of the Society is due to those who have assisted in the preparation of these reports for the very valuable service which they have rendered in making this distinctive contribution to engineering and technical literature.

ALEX DOW,
President of the Society.

Progress in Aeronautics

Contributed by the Aeronautic Division

Executive Committee: Edwin E. Aldrin, *Chairman*, Alexander Klemin, *Secretary*, Archibald Black, Elmer A. Sperry, Wm. F. Durand, and Chas. H. Colvin

POWER PLANTS[1]

THE outstanding feature in the development of aircraft engines during the past year is the great number of engines, both in quantity and in new types, which were produced for non-military activities. The various points of aircraft-engine design to give a light-weight, reliable engine are sufficiently well established that many of these engines give satisfactory performance beginning with the first article produced. However, for the protection of the public, the Department of Commerce conducts tests to determine the airworthiness of aircraft engines. (Department of Commerce Aeronautics Bulletin No. 14, "Requirements for Approved Type Certificates.") By the end of September of this year, airworthiness certificates had been issued for nine engines. Data on these engines are summarized in Table 1. Engines which have passed the standard endurance tests of the United States Army Air Corps or the United States Navy Bureau of Aeronautics will be approved by the Department of Commerce.

There are at least fifty different aircraft engines below 300 hp. at various stages of development. Most of these engines weigh below 4 lb. per b.hp. About one-third weigh 2½ lb. or less per b.hp. The air-cooled radial engine is the predominant type of engine of this class. The price per brake horsepower ranges from $25 for the small engines to as low as $15 for the larger ones.

The Allison Engineering Company has redesigned the accessory drives of the inverted Liberty engine so that both oil and water pumps are gravity fed and the ignition distributers are driven from the camshaft driveshafts instead of from the end of the camshaft. This engine has been thoroughly ground-tested and is now being flight-tested by the Army Air Corps in a Loening Amphibian plane. It is designated as the Allison V-1650.

An item of considerable interest to many is that the Army Air Corps has let the last contracts for reconditioning Liberty 12 engines. Approximately 2000 engines are being reworked, of which about two-thirds are being done by the Allison Engineering Company and the remainder by the Steel Products Company of Springfield, Ohio. Some of the principal changes being incorporated in these engines to improve their reliability are replacement of the old carbon-brush ignition distributers by the air-gap type distributers with coils tested at high temperature, new stub-tooth timing and accessory gears, replacement of bronze-backed by new steel-backed connecting-rod bearings, modifications to provide drives for a fuel pump and the inertia type of

[1] Prepared by N. N. Tilley, Chief, Engine Development and Specification Unit, Power Plant Branch, U. S. Army Air Corps, Wright Field, Dayton, Ohio.

starter, selection of heavy-type crankcases, and modification of pistons and rings to reduce oil consumption. After this stock of engines is depleted, the Army Air Corps can equip all of its airplanes with the latest-type high-performance engines.

The Curtiss Aeroplane and Motor Company has produced a new six-cylinder, double-throw crankshaft, air-cooled radial engine of 600 cu. in. displacement, which they have named the "Challenger." They guarantee 170 b.hp. at 1800 r.p.m. The Army Air Corps is to test one of these engines for training-airplane service.

The Army Air Corps is flight-testing a Curtiss H-1640 ("Chieftain") engine and has adopted, as standard, Curtiss V-1570 and GV-1570 ("Conqueror") engines. The H-1460 is an air-cooled engine. The V-1570 and GV-1570 engines are water-cooled direct drive and geared engines, respectively. These engines develop 600 b.hp. The Curtiss bombing airplane with full military load, equipped with two GV-1570 engines, has a high speed and a rate of climb as good as many pursuit-type airplanes at the end of the War.

The Packard Motor Car Company is developing an air-cooled radial Diesel engine. It is reported to weigh approximately 3 lb. per hp. This marks a big step forward in the aircraft Diesel-engine project. While the fuel economy of this type of power plant may not be appreciably better than that of the aircraft gasoline engine, the use of a non-volatile fuel should considerably reduce the fire hazard.

The Pratt and Whitney Aircraft Company has brought out the series B Wasp engine, developed from the earlier model. This engine is rated at 450 hp. at 2100 r.p.m. With the power of this engine somewhat boosted at sea level by speeding up the centrifugal fan in its induction system, the new Boeing superfighter is reported to have a speed in level flight of 180 m.p.h. with full military load, and to have remarkable maneuverability.

A quantity of Pratt and Whitney Hornet engines and Wright Aeronautical Corporation Cyclone engines is being procured by the Army Air Corps for twin-engine bombing planes, and by the Navy for torpedo planes. Hornet engines are being used in the Boeing Air Mail Service. These engines are rated at 525 hp. at 1900 r.p.m., with a dry weight of not over 775 lb. Both are nine-cylinder air-cooled radial engines.

The Wright Aeronautical Corporation has developed a new J-6 series of engines, each of which will weigh less than the J-5 (Whirlwind) engine. They are 5-, 7-, and 9-cylinder, air-cooled radial engines of 160, 220, and 300 hp., respectively. They offer many new possibilities to the designers of both military and non-military airplanes.

Large-engine development lost considerable impetus when twin engines in preference to a single engine for bombing airplanes and three-engined transports were selected by the Army Air Corps. However, larger disposable loads or maximum speed at any cost will demand larger engines, even in multi-engined planes. Large engines awaiting test by the Army Air Corps are the Allison X-4520 engine and the Packard 4A-2500 engine. The X engine is air-cooled, has 24 cylinders arranged in four banks of six cylinders each, at 90 deg. to each other, is geared 2:1, and is rated at 1200 hp. The Packard engine, one of their 800-hp. engines, modified to incorporate two gear-driven centrifugal compressors, one on each side, and has developed 950 hp. during a one-hour acceptance test. Over 1000 b.hp. should be obtained from this engine. It is expected to test these engines when the new power-plant laboratories of the Material Division are completed.

A number of refinements and new features in engine design have appeared during this past year. Among these are the finer pitch of cooling fins resulting from research at the Massachusetts Institute of Technology, radio-shielded spark plugs, flange-and-spigot-mounted aircraft magnetos, lighter propeller reduction gears, and the Chandler-Marvel mechanical fuel-metering device which may be expected to improve airplane maneuverability, to eliminate intake-manifold distribution difficulties, hot spots, and air heaters, and to facilitate two-cycle development.

TABLE 1 DATA ON AIRCRAFT ENGINES GRANTED AIRWORTHINESS CERTIFICATES BY THE U. S. DEPARTMENT OF COMMERCE

Certificate No.	Manufacturer	Engine name and designation	Rating B.hp.	Rating Propeller r.p.m.	Max. dry weight, lb.
1	Fairchild-Caminez Engine Corp.	447-C	120	960	340
2	Warner Aircraft Corp.	Scarab (R-420)	110	1850	270
3	Kinner Airplane & Motor Corp.	Kinner K-5 (R-370)	75	1725	260
4	Velie Motors Corp.	Velie (R-250)	45	1750	210
5	Curtiss Aeroplane & Motor Co., Inc.	Challenger (R-600)	170	1800	420
6	Curtiss Aeroplane & Motor Co., Inc.	Conquerer (V-1570)	600	2400	760
7	Curtiss Aeroplane & Motor Co., Inc.	Conqueror (GV-1570)	600	1200	870
8	Curtiss Aeroplane & Motor Co., Inc.	Chieftain (H-1640)	600	2200	925
9	Aircraft Engine Co., Inc.	Comet (R-610)	115	1775	350

Supercharger development has reached the position that all high-speed, high-rate-of-climb or altitude airplanes will employ them. The General Electric exhaust-gas-turbine type now has excellent durability. Some of these units have been in service for over a year, with hundreds of hours of operation without failure. A standard Army pursuit airplane, equipped with the General Electric turbo supercharger, with full military load, has gone to 20,000 ft. altitude in less than eleven minutes several times, and has a rate of climb at that altitude in excess of 1500 ft. per min., and a service ceiling of 32,000 ft., which is reached in approximately 30 min. The gear-driven centrifugal supercharger is built into all the large American radial engines. The Army, Navy, National Advisory Committee for Aeronautics, and engine manufacturers are experimenting with the Roots-blower type.

During the past year the Army and Navy have agreed on many power-plant standards and are considering many more items for A-N standardization. Some of the engine parts standardized or being standardized are propeller-shaft ends and hubs, drives and mounting flanges for starters, magnetos, electric generators, fuel pumps, and tachometers. Type designations have been assigned new engines which consist of a number representing the displacement in cubic inches to the nearest 10 cu. in., and a letter prefix to designate the cylinder arrangement and whether direct drive or geared down to propeller, as R for direct-drive radial, GR for geared radial, V for direct-drive vee, GV for geared vee, and H for hexagon.

Airplane Design and Construction[2]

In the field of design and construction the airplane is still evidencing a steady improvement in details and refinements, with no radical departures from the accepted standards. Particular attention is being paid by commercial manufacturers relative to refinements in appointments of their machines. In the matter of design details a very marked showing is manifest in the so-called "cleaning up" of the exposed portions of the machine, in order that the limit of speed may be secured. Generous fillets given to the junction of the wings and tail surfaces with the body, retraction of fittings within the wings and fuselage, and a general streamlining of the landing gear and other exposed assemblies have directly resulted in higher speeds, the power and pay load remaining the same. The recent transcontinental air races are evidence of this fact, as here such planes as the Laird and Waco, identical with former designs except for details, made speeds as

[2] Prepared by Mac Short, Vice-President and Chief Engineer, Stearman Aircraft Co., Wichita, Kan.

THE BOEING TRANSPORT

much as 20 per cent in excess of former records. With the introduction of tail wheels to supplant the tail skid and the continued increase in the use of wheel brakes, the ground-handling problem of the larger as well as smaller planes is much simpler. Hydraulic or oleo shock-absorbing struts for landing gears have received numerous modifications with the use of air, rubber in compression or tension, and steel springs for the static-load or taxiing absorbing medium. Most popular of these is the Aerol strut produced by the Cleveland Pneumatic Tool Co. Triangular or elliptical tail surfaces with almost a universal application of front-spar adjusting gears for the stabilizer are to be noticed. Inset "Frise" ailerons with the remaining control surfaces carrying little or no balance appear as the trend in design regardless of the size of the machine.

More attention is being given to the comfort of the pilot and passengers. Upholstery comparable to that in motor buses and adequate ventilation and heating facilities are replacing the somewhat makeshift appointments that appeared in the earlier cabin-type airplanes. Outstanding among the transport machines is the Boeing, with an electric grill and cabin boy as standard fixtures. Color has not been lacking in the airplane, as various wing and fuselage combinations with suitable striping have brought out lines in a manner similar to that of the modern motor car. With the demand for colors has come a call for special dopes and lacquers that will give high-luster finishes. Berry Bros., du Pont, and the American Varnish Company have contributed greatly to this problem. Military aircraft are not without some vestige of color, as the olive drab is giving way to high-visibility yellow and suitable combinations.

Types among military and commercial manufacturers are definitely appointed, and it is rare that a factory enters both fields. Among the military planes the biplane arrangement is still in the majority; however, a number of Fokker monoplanes are being used by the services for transport. In the commercial field the interest is fairly well divided between the monoplane and the biplane, and again between open and closed models. A recent summary of the licensed airplanes as approved by the Department of Commerce gives interesting facts. Of approximately 50 approved types 25 per cent are three-place open-cockpit biplanes, 16 per cent 5- to 8-place monoplanes, 6 per cent open two-place biplanes, 6 per cent open two-place monoplanes, 6 per cent closed 5-place biplanes, 4 per cent closed 3-place biplanes, and 12 per cent miscellaneous types, such as amphibians, flying boats, and large transports. The latter have received an added impetus due to the rapid establishment and growth of large transport lines. At present the majority of transport planes are monoplanes; that is, the Fokker and Ford versus the Boeing. Much interest will be centered around these machines in the next year.

That the trend is toward more power may be evidenced by the introduction of the Whirlwind engine in smaller planes and the replacement of this engine by the Pratt and Whitney Wasp in the medium-sized cabin models. A further extension in this direction is the replacement of the Hornet and Cyclone engines for the 400-hp. ones. In the military and commercial field alike the larger machines have already reached the maximum-powered units and must either introduce more units or await further development of higher-powered engines. In the multi-engined class the tri-motor of an aggregate of 1200–1500 hp. is gaining favor. With such power a pay load of 14 passengers may be transported at a speed of 140 m.p.h., and, as the air-transport operator points out, speeds of this order are becoming increasingly more necessary. The four-motored combination in which two motors are in tandem has not been without favor in the prospectus or on the drafting board, but as yet it has not appeared on American air-transport lines.

Metal construction either as a composite of steel or duralumin or entirely of the latter is making added inroads into the more common method of construction wherein wood wings and steel-tube fuselages and tail surfaces comprise the main structure. The Pruden, Thaden, Hamilton, and Flamingo are newcomers that are using steel or aluminum alloys for the main structural parts and duralumin sheets for the covering, either corrugated or flat sheets, with frequent seams turned up. Numerous manufacturers are using tail surfaces of duralumin where otherwise little or no use of this metal is made; the assumption being that the operation is easier and the moment that the weight of the assembly produces is materially reduced. Simultaneously with the use of steel and duralumin sheets and sections appear castings and forgings. Many planes show the application of this method of manufacture where in former years elaborate welded or riveted fittings were used. A fair reduction in weight and a lessening of manufacturing cost of as much as 200 per cent has been effected by cast or forged fittings. It is evident, however, that greater production, both in military and commercial craft, has permitted this improvement in methods.

Design characteristics have been improved and construction refined by advances in accessories. Metal propellers, which have substantially replaced wood for all engines of 200 hp. or more, have increased in efficiency, the so-called wide-blade type being very popular. The Curtiss Company has developed a new forged propeller with an integral hub. Hydraulic and mechanical brakes are more prevalent, the latest being the "Steel-Draulic" built by the Aircraft Products Co. Wheels

THE VELIE MONOCOUPE

and tires, both large and small, are in greater demand than before. The transport machines have exceeded the working load on 44-in. tires and wheels, and the lighter craft have demanded smaller tail wheels than the 14-in. size. At the upper end of the scale the problem is as acute as at the lower, except here it is possible to dual the tires, while with small tires the problem of mounting and of the presence of a hub for the wheel becomes difficult. Instruments have become more standard in regard to mounting dimensions, and sizes are being reduced. This latter improvement allows a more desirable grouping of important instruments on those craft that do night and "blind" flying. Electrically heated pitot tubes for the air-speed indicator have aided in flying during the icing period that planes experience in freezing weather.

Records have been broken in all manner of flying. Crossing the continent in approximately 18 hours, remaining aloft in an endurance flight for more than 55 hours, high speeds in excess of 300 m.p.h., outside loops, altitude tests, and many other records have been shattered during the past year. Records in production of all aircraft have reached values never anticipated before. Outstanding in quantity for the past year are the factories making the Monocoupe and Waco planes, where production reached the high mark of 5 to 6 machines per day. In military craft Vought showed excellent manufacturing methods by producing a "Corsair" a day.

Some foreign planes have been introduced, principally in the light field. Avro and De Havilland have both been represented by slotted and non-slotted wing biplanes using the Cirrus engine. Klemm light planes are being manufactured by Aeromarine. Probably the most radical design evolved this year is the new Bellanca P with its odd bracing and retracting landing gear.

AERODYNAMICS[1]

The British Aeronautical Research Committee reports some interesting experiments with a "pilot plane." A pilot plane is an auxiliary airfoil pivoted ahead of a wing so as to provide automatically a slotted wing at high incidence without much increase of drag at fine angles with a 10 per cent pilot plane. The maximum lift coefficient of a R.A.F. 15 airfoil may be increased to 0.80 (British absolute units), and the increase of drag at top speed is less than the minimum drag of the pilot plane when tested alone. The increase in drag is greater on the climb. By making the stop which limits the pilot angle vary with the aileron angle, the pilot plane gives an efficient slot-and-aileron control, the pilot plane reversing the sign of the yawing moments at angles just above the stall.

The delivery of the lecture by F. Handley Page on slotted wings before the Society (Detroit Aeronautic Meeting, June, 1928) has further increased American interest in the subject of the slot, and at least three full-scale experiments are being made with this device in the United States.

The recent flight of the Autogiro from London to Paris has increased interest in this type of aircraft. With the application of more power the Autogiro has shown increased speed, although the maximum speed attained thus far is still below 100 miles per hour. The British have been steadily continuing full-flight wind-tunnel dropping and theoretical investigations on this type of aircraft. A summary of its characteristics indicates that its performance is comparable with that which would be predicted by the application of theory. The performance of the Autogiro is inferior to that of a corresponding airplane of the same weight and horsepower as regards speed, rate of climb, and distance to take off. The Autogiro is able to land more slowly and to pull up more quickly after landing, and, in contrast with an airplane of conventional design, remains stable at large angles of incidence. The only point which remains uncertain is its ability to descend vertically at low speed. This question is not considered to to be of much practical importance, however, since the actual gliding descent at an inclination of 30 deg. to the horizontal implies the possibility of vertical descent when the wind speed exceeds 20 m.p.h. The rate of rotation of the windmill is found to increase slowly with the forward speed.

The theory of performance testing is continually being discussed by British writers. In this regard it is important to determine the law of variation of engine power with height. Glauert concludes that it is more accurate to state that the power of an engine varies directly with the pressure, rather than directly as the density. A more exact statement is that the power is a function of $(\text{pressure})^{3/4} \times (\text{density})^{1/4}$.

A non-dimensional form of the stability equations of an airplane has also been devised by Glauert. The comparison of the stability criteria of different airplanes should be facilitated thereby.

The lateral stability of an airplane under control is a subject of some importance which has not hitherto received much importance. Lateral stability depends upon the values of the resistance derivatives of side force, rolling moment, and yawing moment due to side slip, rate of roll, and rate of yaw. In actual design most of these derivatives are fixed before the lateral stability is considered. Designers will be gratified to learn, therefore, that stability depends mainly on the ratio of L_v to N_v, and not on their absolute values, provided L_v is negative.

[1] Prepared by Alexander Klemin, Professor of Aeronautical Engineering, Daniel Guggenheim School of Aeronautics, New York University, New York, N. Y. Mem. A.S.M.E.

In the aerodynamic design of the airplane, both British and American designers are seeking the utmost refinement in streamline. The De Havilland Tiger Moth and the Lockheed Vega are examples of the tendency to give a commercial airplane the form of a racer. The subject of interference between parts, the cowling of air-cooled engines, and propeller interference are engaging much attention. Prof. Melville Jones arrives at two conclusions of practical importance: (1) In a perfectly streamlined airplane, interference, except of the most extreme kind, can have little influence upon overall performance, apart from a slight superiority in favor of the pusher airscrew over the tractor airscrew. (2) Serious losses due to interference must therefore be attributed to bad streamlining. An important investigation of the Deutsche Versuchsanstalt für Luftfahrt on the oscillation of the internally braced monoplane indicates that the period of vibration of such a wing varies between 500 and 900 per minute. Danger of resonance between the engines and the wing is only likely to occur when the engine is throttled down to a large extent.

The propeller research laboratory of the National Advisory Committee for Aeronautics is being used energetically for investigation of propeller and body interference, the cowling of air-cooled engines, and other problems of practical importance.

Researches at Langley Field, Wright Field, and by the Bureau of Aeronautics seem to indicate that spin, whether flat or normal, can be controlled largely by mass distribution.

The amount of aerodynamic research now being conducted by American institutions renders even a summary difficult. It may be safely said that in this respect American effort is now fully on a par with European work.

Scale effects in particular are being studied intensively in the compressed-air tunnel of the National Advisory Committee for Aeronautics.

The problem of wing flutter has been receiving much attention. Experiments by Zahm and Bear at the Washington Navy Yard have established that resonant flutter is not likely to ensue from turbulence of air flow alone past wings and tail planes in usual flying conditions. Danger of flutter is minimized by so proportioning the torsional resisting moment of the wings to the air pitching moment at high-speed angles that the torsional flexure is always small. Green's paper, "An Introduction to the Problem of Wing Flutter," recently read before the Society, is an important presentation of the present status of the problem.

The importance of the flat-top lift curve as a factor in control at the stall has long been recognized. One or two sections have been designed and tested at Langley Field. They have given the desired flat-top lift curve, combined, however, with low aerodynamic efficiency and high moment coefficients.

AIR TRANSPORT AND OTHER CIVIL FLYING[4]

Since the preparation of the Progress Report for 1927, further and very important progress has been made in the development of air transport in the United States. A considerable number of new routes have been added, and operations on many former ones have been extended. Several air-transport companies are now earning more than the cost of operation, and some are able to show comfortable profits. Already a tendency toward consolidation has become evident, and one of the noticeable changes in this line was the taking over of Pacific Air Transport by Boeing Air Transport, giving the latter company a total operating route of 3017 miles.

Air-mail traffic has continued to increase rapidly, and the inauguration of the reduced air-mail rates on August 1 brought a further sudden increase in traffic, almost doubling it. With the new rate in effect many concerns are sending all first-class mail by air. Some of the more enterprising ones have gone further and are sending out much of their advertising material under air-mail postage. The increased traffic due to this has necessitated an increase in facilities on the part of some operators, and this in turn has resulted in reducing the unit operating costs. An official of one operating company (the Boeing) has recently been quoted as estimating that its airplanes carry 15 per cent of the total first-class mail on one route, the remainder being sent by rail. One development of more than usual importance is the extension of air-mail routes from the United States to Canada and to Central America.

With the air-mail traffic now firmly established, many of the operators have begun to turn their attention to the further development of passenger traffic. It is in this class of activity that the United States has trailed behind Europe, although taking the lead in many other branches of aviation. A number of passenger routes are now in operation, and greater effort is being spent on the development of this type of traffic than heretofore. While always dangerous to make predictions in aviation, it is safe to expect that passenger air travel in this country will soon show a growth comparable with that of air mail in the past.

The recent changes in equipment used for air transport in this country have been mainly in the construction of multiple-engined passenger-carrying airplanes of larger capacity, ranging up to as high as 20 passengers. On some routes there has been a tendency to increase the scheduled speed of trips for the purpose of advancing mail connections, and this has already become reflected in the construction of mail-carrying designs of somewhat higher speed and capable of maintaining an average of about 110 m.p.h. under even adverse conditions. Miscellaneous commercial flying (including "aerial taxi" services) has increased in parallel with the increase in air-mail operations. Several large corporations have purchased airplanes for their own use and are applying them to the transport of high-salaried executives, carriage of rush orders, repair parts, and similar uses where speed is of primary importance. Private flying has similarly undergone a substantial increase, due in a large measure to the attention drawn to aviation by the numerous long-distance flights. Flying clubs are now making their appearance in various parts of the country. In some cases these are formed by wealthy men owning their own airplanes, and in others, by the less prosperous who form a club for the joint purchase of an airplane. The development of aerial express traffic has had no spectacular increase in the past year, but some progress has been made nevertheless.

One of the most significant developments of the past 12 months has been the entry of the railroads into the aviation field. Such an extension of the scope of the railway operators has been discussed frequently during the past few years, but approached reality only with the organization of Transcontinental Air Transport. This corporation was formed by some of the leading railroads, airplane operators, and builders for the purpose of creating joint air-rail services in which the passenger is carried part of the way by rail and the remainder of the trip by air. Initial operation of services of this character was started during the past summer.

As a consequence of all of this increased interest in aviation there has been a very large increase in the number of schools and of students taking flight training. Figures compiled by the Department of Commerce indicate that the number of students now taking up flying about equals the total number of pilots licensed. Interest in airport construction has been continued and has increased to the extent where most of the larger cities have at least some kind of flying field, and the city without one is coming to be regarded as behind the times.

Continued and greatly increased attention has been given to

[4] Prepared by Archibald Black, President and General Manager, Black & Bigelow, Inc., Air Transport Engineers, New York, N. Y. Mem. A.S.M.E.

the selection, design, construction, and equipment of airports. There are now several companies scattered throughout the United States which specialize in this work. While general agreement seems to exist as regards most angles of airport work, there appears to be some variation of opinion as regards the actual layout of the airport itself. In general, this difference seems to resolve itself into a question of planning the layout with regard to the handling of heavy traffic in the future. Some rather novel plans have been advanced, both here and abroad, but it seems rather early to comment on them, and to include description herein would needlessly burden this report.

Such figures as are available on air-mail traffic and mileage in air transport are included in Tables 1 and 2, and are fully self-explanatory.

TABLE 1 AIR-TRANSPORT MILEAGE OF THE WORLD[1]

(Operations of scheduled services in airplane-miles over 12-month periods as nearly possible comparable)

Country of registry	Year 1919	1920	1921	1922	1923	1924	1925	1926	1927
Australia	.....	.....	.....	.....	235,582	262,895	352,847	417,964	.....
Austria	.....	.....	.....	.....	.....	.....	.....	.....	245,043
Belgium	.....	.....	.....	.....	.....	160,000	144,500	.....	.....
Canada	.....	.....	.....	.....	.....	294,778	446,648[4]	631,715[4]	.....
Colombia	.....	2,687	53,650	125,678	134,375	169,500	183,206	.....	.....
Czechoslovakia	.....	.....	.....	.....	.....	126,400	48,300	170,895	257,888
Denmark	.....	.....	.....	.....	56,000	.....	114,500	126,730	116,798
France	.....	505,500	1,460,000	2,015,000	2,115,000	2,249,000	2,946,000	3,243,900	3,755,369
Germany	.....	.....	.....	842,986	885,881	1,860,000[2]	3,070,000	3,816,144[4]	5,921,593
Great Britain	168,000	599,000	259,000	778,000	1,004,000	890,000	865,000	840,000	873,000
Italy	.....	.....	.....	.....	.....	.....	.....	.....	824,474
Mexico	.....	.....	.....	.....	.....	.....	.....	96,800	146,400
Netherlands	.....	50,850	217,000	246,200	336,000	482,800	679,753	597,500	813,510
Poland	.....	.....	.....	66,293	142,057	233,923[3]	465,847	.....	654,873
Soviet Russia	.....	.....	.....	.....	.....	288,600	292,595[5]	311,000[5]	.....
Sweden	.....	.....	.....	.....	.....	69,280	248,610[5]	222,000	206,766
Switzerland	.....	.....	.....	.....	.....	268,400[2]	87,427	210,340	459,720
United States	393,066	880,028	1,828,354	2,329,296	1,743,030	2,220,761	2,910,611	4,407,263	6,009,226
Totals	561,066	2,038,065	3,818,004	5,903,453	6,651,925	9,576,337	12,855,844	15,092,251	20,138,260

[1] Compiled by Black & Bigelow Inc., New York, N. Y. [2] Figure uncertain or known to include duplication. [3] Revised figures. [4] Including some non-scheduled flying. [5] Incomplete. [6] All services suspended for 3 months.

TABLE 2 MILEAGE AND TRAFFIC STATISTICS FOR PRIVATELY OPERATED AIR-MAIL ROUTES WITHIN THE U. S. A., FOR YEAR ENDING JUNE 30, 1928

(Compiled from Post Office Department figures)

Date	Pounds of mail carried	Mail revenue to operator	Airplane-miles flown with mail
July, 1927	99,589	$250,891	375,923
August	102,051	258,963	376,998
September	146,486	312,810	444,519
October	153,649	329,532	449,562
November	141,992	304,083	413,054
December	165,768	353,253	402,267
January, 1928	144,289	300,281	431,310
February	153,363	329,380	450,058
March	173,929	368,191	523,287
April	171,028	359,182	513,144
May	199,409	425,565	616,179
June	210,957	447,642	595,054
Totals for year	1,862,510	$4,039,773	5,591,355
Increase over previous years, per cent	265	205	115

PROGRESS OF NAVAL AVIATION[6]

The past year has witnessed greater aviation activity in the Fleet. The general tendency in Fleet aviation is toward reducing the size of the type for each purpose, at the same time maintaining or improving its performance.

The commissioning of the aircraft carriers *Lexington* and *Saratoga* has aided materially in solving the problem of the role of planes at sea; naturally their operation brings about new problems to be worked out, and progress in this direction is also being accomplished. More extensive use of aircraft on the battleships and cruisers has given the same result.

Further advance in connection with metal construction is in full swing. The prevention of corrosion of light alloys is progressing, and these alloys as well as high-strength non-corrosive alloys are entering into all recent construction.

Of our service aircraft on hand June 30 of this year, 82 were four years old, 16 were three years old, and the remainder had been in service two years or less, hence the Navy is outfitted with modern planes and equipment, wooden propellers and wartime engines being obsolete.

The development of air-cooled engines is in a healthy state, with two permanent companies competing vigorously and several other companies engaged on experimental projects which are of considerable interest. The same competition exists in the field of metal propellers, and experiments on instruments and accessories are also pending which promise desirable results.

Now that the demands of Fleet aviation are approaching solution, the patrol types are again being placed in production. While these planes are too large for operation from ships, they operate to great advantage with tenders or from shore bases. Recently a plane of this type, systematically developed as an experimental project, broke several world's records for endurance and weight carrying. This type is now in production, and three other types which are at present in the experimental stage will be completed before the end of the year.

Thick weather and fog still present problems to which several possible solutions have been offered, but which require extended investigation and development. Progress has been made in navigation, but the safe landing of heavier-than-air craft in a fog is yet to be satisfactorily solved.

Military requirements have resulted in improvement in design staffs of contractors. The Five-Year Building Program with its steady demand has resulted in better organization and a larger force of skilled mechanics. To a degree the same is true of materials, but in this case the increasing demands have served to develop the interest of manufacturers. These good effects are bound to increase, and therefore the Navy Department finds a direct interest in the promotion of civil aeronautics through the development of resources in skilled personnel, materials, and organization.

The Marine Expeditionary Force, particularly in Nicaragua, has gained much valuable experience with up-to-date aircraft under actual operating conditions, clearly demonstrating the value of aircraft and bringing out the lines on which progress should be made. Particularly has the field of military-transport operation and requirements, observation and attack, been well covered.

In liaison with the Army Air Corps, a number of interesting projects are being investigated; duplication is avoided by each

[6] Prepared by Rear-Admiral W. A. Moffett, U. S. N., Chief of the Bureau of Aeronautics, Washington, D. C.

service keeping in close contact with the other on questions of mutual interest. When practicable, specific problems are allocated to Government department especially equipped for their solution, notably the National Advisory Committee for Aeronautics, the Bureau of Standards, the Forest Products Laboratory, and the Bureau of Mines.

In the lighter-than-air field, the *Los Angeles* and the semi-rigids at Lakehurst have been steadily engaged in training and development projects. Methods of mooring and handling have been improved, and much information has been gathered which will be of benefit in the construction and equipment of the large rigids about to be contracted for. The *Los Angeles* has demonstrated that it can land aboard a carrier and be refueled, regassed, and reprovisioned, making possible a greatly extended field of usefulness as well as demonstrating that emergencies can be met. It is expected that two of the largest rigid airships ever built will visit this country shortly and give a convincing demonstration of the commercial possibilities of this type.

To sum up, the Five-Year Building Program, a wise piece of legislation, is progressing in good order, and Naval progress has been advanced thereby. The establishment of the Aviation Branch of the Department of Commerce, and of the three Secretaries for Aviation, has aided not only military development but commercial development. As shown, this commercial development is an important aid in the progress of development of military resources.

PROGRESS IN MILITARY AVIATION[6]

Progress in military aviation and its effect upon aviation in general during the past year has been as rapid as in any preceding year, but this effect has not been so apparent because the development was more in the nature of standard types of planes than in actual change of design. The Air Corps has concentrated upon the training of pilots, refinement in tactics, engine development, and on the planes and matériel. As now established Air Corps planes constitute six principal types: Attack, Bombardment, Cargo, Observation, Pursuit, and Training. The development has been limited largely to adapting existing planes to the newly developed aircraft engines in the 500- and 600-hp. classes.

In the line of equipment, suitable electrical and inertia starters have been made available for all service engines, and initiatory development of double-voltage electric generators gives promise of a big saving in the weight of radio installations.

Progress is being made along the line of metal construction. Initial cost, difficulty of repair, corrosion prevention, and increased weight have been potent factors in retarding the extensive use of metal covering for airfoils, it being felt that a definite and favorable answer to all problems should be obtained before metal construction is generally adopted for peacetime use.

All service airplanes, except primary training, now purchased by the Air Corps are provided with separately controlled landing-wheel brakes operated by pedals on the rudder bar. Investigation of the so-called "flat spin" which caused the crash of a standard service-type airplane led to extensive flight and wind-tunnel research to determine what condition characterized this spin.

Attack Types. The present attack airplane issued to the service is a modification of the Standard 0-1 (Curtiss) Observation type known as the A-3. This airplane meets requirements of the Attack group better than any previous type heretofore used.

Bombardment Type. Continuation of the bombardment program initiated last year resulted in comparative tests of six different airplanes to determine their suitability for procurement to replace the present types.

The most suitable airplanes were found to be the XB-2 and the XLB-6, procurement being made of both models which are biplanes, the former mounting two VG-1570 (Curtiss) engines developing 600 hp. each, and the latter mounting two R-1750 (Wright) engines developing 525 hp. each. An equal quantity of LB-7 airplanes which differ from the LB-5 model only in the substitution of Pratt & Whitney R-1690 engines is also being procured. The performance and flying qualities of these bombers will greatly exceed those of any type now in service.

Cargo Types. In the cargo class two airplanes were adopted for service use, the three-engine C-2 (Atlantic) series as standard, and the single engine C-1 (Douglas) series as substitute standard. Following its momentous flight to the Hawaiian Islands last year, the C-2 completed a very satisfactory service test which demonstrated its reliability and utility for cargo use. On the other hand, the single-engine C-1 model affords a less costly airplane suitable for use where reliability is not such an important factor.

Observation Types. There are four standard observation airplanes at present: namely, the O-1 (Curtiss) series, the OA-1 (Loening Amphibian) series, the 0-2 (Douglas) series, and the 0-11 (Curtiss) series. All of these are equipped with Liberty engines with the exception of the 0-1 series, which uses the Curtiss D-12 engine.

Experimental development was carried on with a new model Amphibian, incorporating a new vee-type air-cooled power plant and a single landing wheel in the center of the hull.

Pursuit Types. The P-1 (Curtiss) and PW-9 (Boeing) series of airplanes, using Curtiss D-12 engines, continue as standard pursuit types.

A few supercharged P-1 type airplanes were recently procured, under model designation P-5, for high-altitude work. These are equipped with Curtiss D-12-F engines with side-type superchargers.

Training Types. The PT-3 with Wright J-5 air-cooled engine was approved as the standard training type, in addition to the PT-1 which mounts the Wright E water-cooled engine.

Other Developments. Considerable work was done in aerodynamical research studying control characteristics, automatic leading-edge slots, methods of predicting performance of airplanes, and in wind-tunnel experiments. In general airplane development, make-ups have been constructed to determine ideal cockpit arrangements for corps observation, twin-engine bombardment and twin-engine airplanes for night observation, long-range day observation, and light bombing.

Aircraft Power Plants. The outstanding characteristic in power-plant development of the year was expansion of the air-cooled-engine field, with progress centering about the conventional radial type. Demands for increased power and flight performance, however, emphasized the need for experimentation on other types of air-cooled engines, and the more important experimental developments have been in this direction.

Progress on air-cooled engine design has, while satisfactory, not warranted abandonment of the water-cooled type, because there is yet no definite assurance that high-speed supercharged engines can be cooled successfully with air, nor has the development of the air-cooled engine reached the stage where it can supplant the water-cooled engine satisfactorily for high-speed work. These reasons, together with excellent prospects of improving performance of water-cooled power plants through higher crankshaft speeds, supercharging, and higher cooling temperatures, have warranted continuance of experimental water-cooled development.

Supercharger development has continued on the exhaust-turbine type, the Roots type, and the built-in geared centrifugal type. A new exhaust-driven supercharger, the Form F-2, was developed for 600-hp. engines and incorporates several general improvements over previous models.

[6] Prepared by Major-General J. E. Fechet, Air Corps, U. S. A., Chief of the Air Corps.

The most interesting and possibly the most important step in carburetor development is the application of the mechanical metering system to aircraft engines. This work started with preliminary tests of two systems. The most promising system was selected for development, and in bench tests which were highly satisfactory the distribution variation between cylinders was less than 2 per cent at all speeds. The units have been fitted to a Curtiss D-12 engine for performance and endurance tests.

The principal activity in ignition work involved double-magneto development, although some work was done on single magnetos, battery ignition systems, and spark-plug requirements.

Evaporative cooling and high-temperature cooling liquids have major considerations in cooling-system development as a means of reducing weight of radiation surface required.

The evaporative cooling system developed for the Wright E engine is undergoing service test, and experimental work has been extended to produce a similar system for other service engines.

Equipment. Development of all classes of aerial photographic, electrical, instrument, radio, and miscellaneous equipment and accessories has been characterized by a consistent effort to improve operating efficiency of aircraft, individually and collectively, by means of new and improved devices and better installation arrangements.

In cooperation with the Fairchild Aerial Camera Company, the Air Corps has now in production or in preparation for production the most complete and perfected set of aerial-camera equipment in its history, and which it is believed far surpasses the photographic equipment of any other nation.

Other of the more important projects involve the following phases of activity:

1 Development of double-voltage generators; standardization of airdrome lighting equipment, and methods of flood lighting.

2 New liquid and gaseous oxygen equipment; improved instruments and methods for navigation and fog flying, including capacity altimeters and leader-cable methods for landing.

3 Experimentation with radio beacons and short-wave sets.

4 Development of detachable and form-fitting parachutes and improvement of seat and lap types; redesign of heavy-duty refueling units; photographic trucks, and balloon winches; redesign of electric-driven orientators and development of an air-blast-controlled orientator.

5 Development of tow targets, and miscellaneous aircraft accessories.

Lighter-Than-Air Craft. The trend of airship development for training purposes is toward enclosed cars having a welded tubular structure covered with doped cloth to afford complete protection for the crew. Air-cooled power plants are preferred to water-cooled types for the reason that no maintenance of the cooling system is required.

A number of other developments have been made in airship accessory equipment, including the helium purity indicator, mooring and handling equipment, winches, and other station equipment.

The rate per thousand flying hours of accidents due to engine trouble was reduced during the past year to one-third of the average rate prevailing in the two previous years. These accident rates indicate that 63 crashes from engine troubles were prevented by new methods and equipment. The lessening of aircraft accidents has, in a measure, been due to the installation at all Air Corps activities of the visual inspection system. By means of large charts posted on the wall of the hangar adjacent to each airplane, on which notations are entered from time to time in spaces provided therefor as to the operating conditions, flying time, performance, etc., of the airplane, an exact history of each airplane is available at first hand. Special sets of tools and equipment—part of the visual inspection system—have been furnished for each airplane in commission.

The equipment of a Transport type C-2 airplane as a laboratory and its use in connection with research work on aircraft radio problems while in the air made it possible to investigate problems and conduct tests heretofore not possible, and further, has contributed more than any one thing toward overcoming difficulties encountered in this line of work. Important investigations have been carried out in connection with radio beacons, high-frequency transmitters, and receivers, transmission phenomena, double-voltage generators, and capacity altimeters.

The increase in radius of action of planes now used by the Air Corps has necessitated closer and more general study of aerial navigation by Air Corps personnel. The Flying Laboratory has also been equipped with special instruments for the purpose of carrying out research problems in aerial navigation.

During the fiscal year 1928 the Army Air Corps photographed areas in the United States approximating 35,000 square miles for the War Department and other Governmental bureaus.

Two methods of training were placed in operation at the Air Corps Primary Flying Schools, the "all through system" at Brooks Field, and the "stage system" at March Field. Both methods of flying instruction are being carefully studied, and it is possible that at some future date a training system will be evolved incorporating the relative merits of each.

If the succeeding years show a rate of improvement in personnel, matériel, and tactics commensurate with that of this year, there is no doubt but that the United States will continue its place as one of the foremost countries in military and commercial aeronautics, if not the greatest.

AIRSHIPS[7]

The outstanding airship event of the year was the voyage of the *Graf Zeppelin* with passengers and mail from Friedrichshafen to Lakehurst. The successful completion of the voyage in spite of bad weather and an accident to the port stabilizing fin proved that the airship shares with the steamship the ability to reach its destination in spite of adverse circumstances. The general public compared the time of the *Graf Zeppelin*, 110 hours from the middle of the European Continent, 3425 nautical miles from Lakehurst by the great circle, with the *Mauretania's* record record of 122 hours from Sandy Hook to Cherbourg, a distance of only 2925 nautical miles. The difference in the lengths of the voyages and the fact that steamships are frequently delayed by storms and mishaps were overlooked.

TABLE 3 COMPARATIVE CHARACTERISTICS OF THE AIRSHIPS "LOS ANGELES," "GRAF ZEPPELIN," AND "ZRS-4"

	Airship		
	Los Angeles	*Graf Zeppelin*[1]	*ZRS-4*
Nominal gas volume, cu. ft.	2,470,000	3,708,000	6,500,000
Length overall, ft.	658.3	776.2	785
Maximum diameter, ft.	90.7	100.1	132.9
Height overall, ft.	104.4	110.6	146.5
Gross lift, lb.	153,000	230,000	403,000
Useful lift, lb.	60,000	108,000	182,000
Number of engines	5	5	8
Total horsepower	2000	2550	4480
Maximum speed, knots.	63.5	69.0	72.8
Range at 50 knots, naut. miles.	3500	6850	9180
Slenderness ratio	7.25	7.75	5.90
Ratio of useful to gross lift	0.39	0.47	0.45

[1] NOTE: For purposes of comparison, the *Graf Zeppelin* is assumed to be inflated with helium. When inflated with hydrogen and fuel gas, her range at 50 knots is about 9000 nautical miles.

The U. S. S. *Los Angeles* made a notable voyage in February and March to the Panama Canal Zone. The outward voyage was a non-stop flight from Lakehurst to New York and thence to

[7] Prepared by C. P. Burgess, Bureau of Aeronautics, Navy Department, Washington, D. C.

Panama. Returning the ship refueled at the mooring mast of the U. S. S. *Patoka* off the south coast of Cuba.

Construction of the two great British airships, *R 100* by the Airship Guarantee Co. and *R 101* by the Air Ministry, has continued, but hopes of their getting into the air in 1928 were disappointed.

In the United States, a contract has been placed by the Navy Department with the Goodyear-Zeppelin Corporation for the construction of two rigid airships of 6,500,000 cu. ft. volume each. The designs of these ships show a very great advance over any previous airships. They will have a full speed of 72.8 knots, and a range of 9180 nautical miles without refueling at 50 knots speed, as compared with 63.5 knots full speed and 3500 nautical miles range at 50 knots for the *Los Angeles*. Their hulls will contain hangar space for five small fighting or scouting airplanes. A new type of girder construction will be employed; and the strength of the ships will be relatively about double that of the *Los Angeles*.

The principal characteristics of the *Los Angeles*, *Graf Zeppelin*, and *ZRS-4* are compared in Table 3.

Construction of the small experimental metalclad airship *MC-2* for the Navy Department has been continued by the Aircraft Development Corp., of Detroit, Mich. A decision to change the hull plating from duralumin to the new metal, alclad, which is very much more resistant to corrosion, afforded an opportunity to test to destruction the tail cone which had already been constructed of duralumin. The test showed that the structure had great tenacity, even when badly crumpled by internal suction amounting to nearly half an inch of water. It was impossible to burst the plating by an internal pressure as high as 14 in. of water.

ALEXANDER KLEMIN, *Secretary*.

Progress in Railroad Mechanical Engineering

Contributed by the Railroad Division

Executive Committee: William Elmer, *Chairman*, Marion B. Richardson, *Secretary*, Eliot Sumner, A. F. Stuebing, R. S. McConnell, and A. G. Trumbull

THERE are some important developments to record in our field during 1928. There has been a continuation of steady progress along the lines of a better utilization of equipment, with the result that the manufacturers of locomotives and cars have had another year of minimum business. Long engine runs, better engine maintenance, and a still further drop in the weekly car loadings than 1927 showed below the 1926 figures have resulted in storing a large number of locomotives in good order.

The railway-equipment manufacturers and related industries are confronted with a serious economic problem due to the tremendous fluctuations in the volume of orders. Since 1900, the annual orders for locomotives have ranged from 214 to 6265, and for freight cars from 22,062 to 341,315. In 1927 the number of locomotives ordered was only 56 per cent and the freight cars only 76 per cent of the average for the last five years. During the first nine months of 1928 but 50 per cent as many locomotives and cars were ordered as in the corresponding period of 1927, so the builders are operating at 29 per cent and 38 per cent of normal. The producers hardly know what to do to arrange for a curtailed output in the future, fearing that extreme demands will be made on their plants and equipment as in the past.

INFLUENCE OF AUTOMOBILE AND AIRCRAFT COMPETITION

The influence of activities in the automotive field is affecting other branches of industry. Also, with the larger application of automotive vehicles taking the place of older existing constructions, the railroad-equipment industry must fit its equipment to take care of such developments in practice.

The surplus-car figures have also remained at high levels throughout the year, and there has been no lack of adequate transportation in any part of the country. In fact, for practically the past twelve months, every car of whatever class, ordered by any shipper anywhere, has been delivered to him for loading on the day he asked for it.

The general speeding up of freight transportation throughout the country continues to be developed. While this report is being written, the technical papers record the cutting down of time for the delivery of fruits and perishables from southeastern Texas to the St. Louis market by two days. During the past spring the Florida lines improved their service and reduced the time to northern markets by two days. The Commerce Year Book of the U. S. Department of Commerce has this to say in its most recent publication:

> Economy and efficiency have been particularly noticeable in the operation of our railways since 1923. Traffic was moved without delay or interruption, with no car shortages and high car surpluses. The movement of goods during 1927 was completed with the greatest rapidity in railroad history. Gross ton-miles per train-hour during the year showed an increase of 47½ per cent as compared with 1920. The railway executives have now accomplished their objective—to have the right kind of car at the right place at the right time and in proper condition, and to make prompt delivery of all shipments at point of destination.

But there is another side to this picture. As of December 31, 1919, the Interstate Commerce Commission set the value of the railroads of this country at $19,800,000,000. In accordance with the terms of the Transportation Act, 1920, it decided that a fair return on that valuation was 5¾ per cent, but no guarantee of such a return was contemplated; as a matter of fact, it has never been earned. Notwithstanding the billions of dollars invested since, and the acknowledged efficiency and economy with which the railroads are being operated, the return being earned on the investment has dwindled until it almost ranks with savings-bank interest. Privately owned automobiles and buses have reduced railroad passenger earnings until they are now about $800,000,000 less per year than they would have been if the rate of growth had continued since 1920 as it had been before.

At first it was thought that the competition of buses would be limited to short-haul riders, but the length of bus routes has grown until it has reached transcontinental proportions. The trip from New York to Los Angeles takes less than six days. On the Pacific Coast there are buses in operation which carry 26 passengers, with sleeping accommodations, meals, and toilet facilities.

The past year has seen in print considerable criticism of the railroad industry for its apparent lack of progress as compared to other industries, and many comments have been made relative to

its unfavorable economic situation. Quoting a recent editorial from a prominent newspaper: "The buses and the airplanes are cutting deeper every day into passenger revenues. The bus takes the short hauls now and the airplane is likely to take the long ones before many years. The prospect for freight traffic is little better. The tendency in industry is against the movement of bulk freight by rail. Oil moves by pipe line; more efficient power plants burn less coal and burn it nearer the mines. Congestion in the rail terminals and lower costs are bringing a renaissance of inland waterway traffic for bulk freight. The trucks are taking much of the short-haul freight." The views expressed in this editorial are a fair sample of many others, and, because of the effect that a general belief in such views may have on the railway mechanical engineering profession, the Railroad Division considers it advisable to present the following facts relative to the present economic condition of the industry.

In spite of adverse conditions, the railroads have invested so much capital and used it with such skill and have been so successful in gaining the cooperation of shippers and employees that railway properties have been put in unprecedentedly good condition; that railway service has been made better than ever before, and that, in proportion to the wages and prices they must pay, the railways are more economically operated now than ever before.

Since 1920 the average speed of freight trains has been increased 25 per cent, the average number of freight cars in each train, 34 per cent, and the average hourly service rendered by each train in carrying freight, 38 per cent, while the amount of fuel consumed in proportion to the service rendered has been reduced 22 per cent. As to congestion in rail terminals, there has been practically no such congestion for five years.

The railroads now have 33 per cent less passenger business than eight years ago. Previous to the war their freight business increased an average of 5 to 10 per cent a year, but since 1920 it has increased an average of less than 1 per cent a year. This diversion of business in the future will have the same effects it has already had: namely, to make larger than it would otherwise be, the cost of handling each unit of their traffic and to curtail their net return.

It is plain that if present tendencies are not arrested they will result in crippling the railways. If they are to be arrested in time, organized and powerful resistance must be offered to them. Public men and men in other lines of business apparently will do all they can to break down the railroads until those who make their living in railway transportation do what is necessary to make them realize that this is what they are actually trying to do. It is on account of this situation that a considerable portion of this report is devoted to the economic situation of the railroad and railway-supply industries.

Twenty-five years ago the Wright Brothers succeeded in staying in the air a few seconds and flying 700 feet. In 1908 Blériot flew across the English Channel. Last year Lindbergh flew from New York to Paris in 33½ hours, and last month Goebel flew from Los Angeles to New York in 19 hours. Airplanes have stayed in the air 65 hours, have attained speeds of over 300 miles per hour, have crossed every ocean, and are flying millions of miles each year in commercial service.

To take but a single company, the Imperial Airways, Ltd., of Great Britain, has flown its ships in the last three years over 2½ million miles, and carried over 50,000 passengers without a single injury of any kind to any passenger.

The railroads of this country have not done much yet to meet this competition, with the exception of three Eastern and three Western lines. One of these groups announced last summer the formation of a company to establish a coast-to-coast air-rail service. Passengers could leave New York about six o'clock in the evening and ride in a sleeping car to Columbus, Ohio, where they would arrive after breakfast the next morning. Taking a plane there, they would fly to Kansas City by evening, and then ride in a sleeper again to a point in New Mexico, where they would fly to Los Angeles, arriving there in the afternoon, making a two-day trip. The other route provides for leaving New York by sleeper in the evening, disembarking from the train after breakfast the next morning at Cleveland, and flying to Chicago from there. A scheme has also been set up for transcontinental passengers arriving in Minneapolis or St. Paul in the morning, flying to Chicago in 3½ hours, and then resuming their train journey by sleepers leaving about noon.

LOCOMOTIVES

During the past year, however, the railroads have not been idle. In addition to the constant efforts to speed up rail transportation which have already been referred to, there has been continuous progress in the direction of building more powerful locomotives.

Attention was called in the report of progress in railway mechanical engineering which was presented by the Railroad Division during the Annual Meeting of The American Society of Mechanical Engineers in 1927, to the increased use of the four-wheel trailer truck. Most of the locomotives built during the past year with four-wheel trailer trucks, have been of the eight-coupled type, some with two-wheel leading trucks and others with four-wheel leading trucks. The primary object of the four-wheel trailer truck is to secure larger boiler capacity and better boiler proportions. Larger boiler capacity means more horsepower, and more horsepower means the maintenance of existing schedules with heavier trains in passenger service and the hauling of heavier trains or increases in speed, or combinations of both of these factors, in the case of freight-train service.

The trend toward intensive capacity development in single-unit coupled wheelbases, has left little field for the compound articulated locomotive with its excessively large low-pressure cylinders and high back-pressure horsepower and its difficult working stresses at other than slow speeds. The substitution of simple for the compound cylinders, however, has given the articulated type a new lease of life and it is performing splendid service on a number of railroads. This type of locomotive continues to receive attention where extremely large tractive force is required, where grades are long and heavy, or where drag traffic predominates.

There is a marked tendency toward the use of the booster with the four-wheel trailing trucks, and in some cases, where the boosters were not actually applied at the time the locomotives were built, provision has been made in the design of the trailer to permit their application later. An interesting application of auxiliary power to meet special conditions has been made on two railroads during the past year. On the Norfolk & Western and the Missouri Pacific, the tender trucks of several locomotives for use in hump-yard service have both been replaced with auxiliary locomotives or tender boosters to permit the maximum proportion of the combined weight of the locomotive and tender for adhesion, in service where the slow speed does not ordinarily place a heavy tax on the boiler capacity.

Considerable attention is now being given by locomotive designers toward obtaining more efficient utilization of the steam after it leaves the boiler. The most noteworthy development to report is the installation of the Caprotti valve gear on the *President Cleveland*, a 4-6-2 type locomotive, built at the Mt. Clare, Md., shops of the Baltimore & Ohio. This gear, previous to its installation on the *President Cleveland*, was in service for about 15 months on a 2-8-0 locomotive on the same road. A number of railroads are considering the uniflow system in connection with

high boiler pressures. Limited cut-off is now an established fact and is being incorporated into much of the new freight power being built.

Alloy steels are being used more extensively in locomotive construction. The use of nickel steel in boiler construction is receiving considerable attention, especially in Canada. The tendency toward replacing built-up structures with single-steel castings, is shown in the year's developments. Tender frames, including the bottoms of the water tanks, are now frequently produced as single castings. Cast-steel locomotive beds have been used in numerous instances and designs are now ready, with the entire locomotive frame, including all cross-ties, valve-motion supports, cylinders, valve chests, smokebox and stack, all in one casting. Improved stokers can now be secured which fit on existing engines and fire through the present fire door. The water-tube boiler demanded by the higher steam pressures is past the experimental stage, and the three-cylinder engines are giving a good account of themselves.

The use of the Type "E" superheater and the multiple throttle is growing, and recent experiments with pinhole air openings in table grates indicate a considerably greater economy of fuel as compared to finger grates.

In other types of motive power there are improvements in electric locomotives which add to the efficiency and economy, and the Diesel electrics are gaining in popularity. The gas-electric railcars are being sold in increasing numbers, and a steam car with a high-pressure flash-type boiler and automobile-type multi-cylinder engine is being introduced. Turbine-driven locomotives, both direct-gear and clutch drive and electric drive, are still under experimentation in Europe, and none has been used in this country. The Argentine Railways have reported success with a turbine locomotive.

CARS AND EQUIPMENT

In the car department the most important development is the extension of the use of roller bearings, large orders for passenger equipment with roller bearings having been given during the past year. Several manufacturers are now ready with roller bearings for freight cars, and these will probably be under experiment in the near future.

Any discussion of the progress in freight-car design must deal largely with the progress of the standardization program of the American Railway Association, Mechanical Division. To the single and double wood-sheathed box cars, which are now standard of the Association, has been added the general design of the standard stock car built up on the single-sheathed box-car frame. The A. R. A., Mechanical Division Committee on Car Construction, presented proposed designs for standard 50-ton and 70-ton self-clearing hopper cars; two designs of "unrestricted" automobile cars, one with 10 ft. $7^1/_8$ in. side-door openings and the other, 50 ft. 6 in. in length with 12-ft. side-door openings. The Committee reported that the proposed "unrestricted" dimensions of the car equipped with staggered 10-ft. side doors, having openings 8 ft. $6^3/_8$ in. in height, would meet the requirements of the majority of automobile shippers. It appears that the demand for door widths in excess of 10 ft. is at its maximum at present, due to the tendency toward the production of smaller passenger automobiles. Commercial automobiles, of course, require car doors of greater width, which is the reason for having a design with 12-ft. doors.

The advantages of standardization of equipment, which circulates as universally as do freight cars, are well understood and require no restatement in this report. However, it is well to keep in mind that standardization also implies the end of development, the completion of progress. The future condition of railroad equipment depends upon the ability to maintain a nice balance between the best of the past crystallized in standard forms, and the new forms which the present has to offer. The American Railway Association is a voluntary organization and none of its standards are sacred; each will survive or be replaced on its own merits, which in itself is sufficient assurance that all legitimate outlets for future progress are safeguarded.

The past year has shown a continuation of the tendency toward special interior arrangements of club- and lounging-car facilities for use on long-distance trains. This has also been accompanied by marked individuality in the treatment of interior decorations, hangings, and furnishings. Close attention to the arrangement of the kitchen and serving facilities has led to a number of unique arrangements in dining cars. Such modern items as electric refrigeration, heating and ventilation, radio entertainment, barber and valet service, are beginning to find their place in the "crack" train service now being furnished by the railroads.

The extreme length and weight of freight trains now being operated on some roads introduce severe operating conditions for air-brake equipment, and experiments have been made to ascertain the requirements for satisfactory service under such conditions. Special endeavors are being made to eliminate moisture and dirt from brake apparatus and to improve the construction of all component parts so that they will function for a longer service period without attention. Because of the extreme length of trains, communication between the locomotive and caboose is a serious problem, and experiments have been conducted to determine the feasibility of transmitting sound signals through the compressed-air train line.

Attention is being directed to the improvement of the spring support between trucks and car bodies with a view to avoiding excessive loads on rails, minimizing side sway of cars with higher center of gravity, and improving tracking on curves. Devices developing combined spring and frictional resistance are being introduced experimentally in an effort to solve this problem.

In the field of shop tools and equipment, radical changes are taking place. The growing size and adaptability of milling machines is improving the quality of the work and reducing the cost, and precision grinding is being used on numerous operations which were formerly done on other machines. Grinding the cylinders of air pumps, for instance, gives perfect alinement and a glass finish which greatly lengthens the period between overhauls.

Electric and gas welding are being more universally adopted, and welded buildings and bridges are now being used.

MAINTENANCE OF WAY

In the maintenance-of-way field there is a growing tendency to utilize labor-aiding machinery, and ballast-cleaning, tie-tamping, and rail-laying operations are now done mechanically on a large number of roads.

A special ballast-cleaning machine has been developed for one of the Eastern roads which has a capacity of cleaning more than 1000 ft. of the intertrack space an hour. It digs up dirty ballast from between the ends of the ties on adjacent tracks, screens the dirt out, carries the dirt to a series of hopper cars in the rear, and deposits the clean ballast back in the "seven-foot."

Building up battered rail ends by electric and gas welding has made great progress, and is now being frequently used to restore smooth-riding qualities to worn rails.

PROFESSIONAL SERVICE

The Railroad Division's Sub-Committee on Professional Service presented its final report on the general subject of the mechanical engineer in the railroad and railway-supply industries at the Student Branch Meeting of the Metropolitan Section on March 14, 1928. This report was published in Transactions,

A.S.M.E., vol. 50 (1928), no. 11, paper no. RR-50-2. In addition representatives of the Sub-Committee on Professional Service have met twice with representatives of the Society for the Promotion of Engineering Education, Committee No. 25, Relations of Colleges and Railroads; the America Railway Engineering Association, Committee No. 24, Relation of Colleges and Railroads, and the Committee on Public Relations, Eastern President's Conference. These meetings, which are to be continued, have been promoted by Committee No. 25 of the Society for the Promotion of Engineering Education. Although only two of these joint sessions have been held during the past year, there is evidence that they are already beginning to show results. It was voted at the meeting held in Pittsburgh, Pa., during the Spring Meeting of the A.S.M.E., May, 1928, to continue the discussion further at the Annual Meeting in December, 1928.

Questionnaires mailed to the honorary chairmen of the student branches of the A.S.M.E. resulted in a total of 37 replies. Seven questions were asked, the answers to which will be reported and discussed in a paper to be presented at a later meeting. Of the 37 technical institutions, 10 favored a special course in railway mechanical engineering, while three stated they were in favor of such a course for graduate students. Quite a few reported that they believed it impossible to work in such a course with the regular four-year curriculum. A large majority expressed the opinion that the railroads did not offer as attractive a field as other industries, and that the salaries at starting were too low. One of the most interesting results accomplished by sending out this questionnaire was to learn that quite a number of educators in mechanical engineering do not approve of the four-year special apprentice course offered by many of the Class I railroads. Furthermore, some went so far as to state that the present special apprentice-training courses did not prepare the technical graduate for the kind of work he was to do, and that they kept good men out of railroad work. The most general criticism was that the special apprentice course only led to work in the mechanical department and did not prepare men for work in the other departments.

Considering the findings of the Railroad Division's Sub-Committee on Professional Service, together with the replies to the questions sent to the various technical institutions, it is believed that an institution offering courses in mechanical engineering could offer a better-balanced course if the design of motive power and rolling stock were included in the regular mechanical-engineering curriculum.

The Executive Committee of the Railroad Division wishes also to report that the President of the Society has appointed a Standing Committee on Professional Service which has held one meeting, and that the work of investigation initiated by the Railroad Division Sub-Committee is being continued by a number of other professional divisions of the Society.

WILLIAM ELMER, *Chairman.*

Progress in Machine-Shop Practice

Contributed by the Machine-Shop Practice Division

Executive Committee: L. C. Morrow, *Chairman,* Carlos De Zafra, *Secretary,* J. H. Connolly, J. W. Hook, W. W. Tangeman, and W. J. Peets

IT IS the object of this report to summarize the progress made in machine-shop practice during the 18 months concluded by the year 1928. The overlapping into 1927 is intentional, since the report each year must be written three months prior to the end of the year, and because there is no definite line of separation between the progress of one year and that of either the next or the preceding year.

In last year's report it was predicted that during 1928 there would be further use of hydraulic feeds and drives, anti-friction bearings, heat-treated alloy steels, pressed-steel and welded parts, automatic lubrication, safety devices, and automatic operation. It is not particularly to the author's credit that in every respect this prediction has come true. The ideal in machine-shop practice, which in its broader sense includes the design of metal products, as well as the operation and management of the machine shop, sets up as a goal the production of improved products at reduced production cost; procedure along the lines indicated was therefore to be expected.

Also, as predicted, progress has been made in the development of standards, notably for Woodruff keys, machine tapers, gear nomenclature, and other gear standards. Details of progress in standardization will be given later in the report. There still is much to do in the way of standardizing nomenclature, initial machine speeds, machine-tool capacity and performance, belt pull, and so on.

Radical improvement in cutting tools was foretold, although the time of the appearance of such developments was left indefinite. It is gratifying, therefore, to be able to report that there have been placed on the market new steels, and such alloys as Carboloy and Widia, are claimed to be capable of removing much more metal than is customary during a unit of time; there are also cobalt-steel drills for drilling manganese steel and improved high-speed steels. There is evidence in the introduction of these new metals or alloys that within a few years our present-day metal-working machines may be entirely obsolete so far as their capacity, relative to the capacity of cutting tools, is concerned. This situation indicates that the production policy from now on should be one of extracting from equipment of present design all of the production of which it is capable. There should be no pampering, no policy of conservatism, so far as the ultimate life of the machines is concerned. No policy of neglect or lack of maintenance is advocated, however, since upon the condition of the working equipment depends the quality of output.

While there have been some outstanding developments since the last report of the Division, the period as a whole has been one of refinement of the features of advanced design initiated during the preceding period. According to one contributor to the data from which the report is compiled, there has been a "marked tendency toward the concentration (by manufacturers) on those types of machine tools that are of more or less standard construction, but are adaptable by the use of attachments and special tooling to the highly specialized requirements of continuous production. It would seem for the time being that American manufacturing progress has definitely settled on this type of production machine, rather than on the completely special machine on the one hand or the standard machine with simple tooling and multiplicity of simple operations on the other." This conclusion appears to be well founded and admirably expressed.

Another contributor, looking at the economic rather than the operation side of the progress in machine-shop practice, says: "I believe these [the most significant developments] are primarily the return to quantity production in the Ford plant and some of the methods employed in that production." The Ford return to quantity production was without question of great importance. Several automobile makers and many parts makers were marking time until they knew what Ford would do. Tool makers were in the same condition. This period of stagnation was changed into one of activity once Ford had exhibited his new product.

Still considering the economic side of progress, and referring to the more or less exaggerated statements concerning unemployment, the same contributor states that "this subject of unemployment developed a sort of research which uncovered new economic factors in the refining of industrial methods and equipment. It rather points out in some cases that the progress in machinery is faster than the change-over in worker intelligence, for at times the adoption of newer methods must be slowed up to accommodate the transition of workers employed, either by absorption in other processes or by accustoming them to the demand made on their intelligence by the newer method." This statement is an attempt to analyze one phase of the mechanization of industry.

Somewhat by way of prediction is another contributed statement: "A point that is in evidence is the development of primary functions and their use, and the combination of these in conforming to any given process required in production. There is a tendency to make primary motion and integral parts of the machine more nearly conform to the requirements of production in their mechanical limits and in the number of functions that are combined. Standardization in such units is of course conducive to economy of manufacture and simplicity of repair, and makes the completed piece of equipment more exactly fitted to the exact requirements of the job; that is, we shall not have in future equipment so much compromise, having at some times too much machine for the job and at other times too much job for the machine." This line of reasoning, although expressed by a single contributor, may be expected to represent the thought of at least a minority of the machine-tool-building industries, and indicates a fair consideration of the machine-tool user's needs.

DIRECTION OF PROGRESS AS MEASURED IN TERMS OF MACHINE-TOOL DEVELOPMENT AND IMPROVEMENT IN PROCESSES

Passing to the less general, the direction of progress, as measured in terms of machine-tool development and the improvement of processes, is indicated by:

1 Increased rigidity and further ease in and rapidity of manipulation
2 Increased use of welding, including multiple-spot welding
3 Further application of hydraulic feeds and drives
4 Greater use of alloy-steel gears and shafts
5 Extended application of anti-friction bearings
6 Greater attention to lubrication, directed especially toward making it automatic
7 Developments in honing equipment
8 Developments in forging methods and equipment
9 More extensive motorization, including the use of separate motors for auxiliary purposes
10 Increased use of diamond boring
11 Development in processes of finishing the teeth of gears, including the burnishing and shaving methods
12 Improvements in balancing equipment
13 Wider adoption of multiple V-belt and multiple-chain drives
14 Increased use of the coining operation to secure closer finish
15 Wider application of grinding.

To expand upon some of these items:

Welding is being applied on an increasing scale to structural steel for the replacement of castings and forgings. The advantages claimed for welded construction are that it saves the making of patterns, in many cases eliminates machine operations, and in others reduces the amount of stock to be removed; furthermore, that it reduces the time required to build a product, as well as the weight of the product.

In the realm of forging, there has been introduced the "internal displacement method," by which straight-carbon and alloy steels can be forged by the process of progressive deep piercing. After upsetting, progressive dies force the stock into the finished shape. The blank is progressively sheared so that the resulting end will be square. As the process progresses, a piercer is supported in the impression made by the previous one.

The multiple V-belt drive, according to a manufacturer who uses many machine tools, now permits the use of his equipment up to the limit of cutting of which the tool steels are capable. This type of drive has been adopted on several makes of machines, including among them centerless grinders and polishing heads, both belonging to the high-speed group, on which a minimum of slippage can be allowed.

Among the outstanding specific developments, including processes and equipment, are the following:

16 Brazing in an atmosphere of hydrogen, and the furnaces to accomplish this process
17 Small sizes of jig borers
18 Automatic plating, using integral conveyors
19 Application of conveyor assembly methods to general manufacture
20 The gear-shaving machine
21 A hardness-testing machine by which balls in great number are dropped on the surface to be tested, the amount of marring that results being in inverse ratio to the hardness
22 A milling machine with hydraulic table travel
23 A process of magnetically controlled carbon-arc welding
24 Steel tools for cutting manganese
25 Developments in the nitriding of steel
26 An improved generator, for producing continuous-toothed herringbone single-helical and straight-toothed gears
27 Application of the unit milling head to the planer-type milling machine, employing two motors, one for the spindle and one for traversing the head and the spindle quill
28 A die-casting machine of automatic operation, the only functions of the operator being to manipulate the single clutch lever, supply new metal, clear and oil the die with an air hose, and watch the castings
29 An automatic internal grinder in which the wheel starts grinding from the rear of the work
30 A hydraulic crankpin grinder which finishes all crankpins of automobile crankshafts in one set-up of the work.

Some of the items enumerated deserve further definition:

Brazing with copper, to secure a perfect alloy weld between surfaces that could be united only with difficulty by any other method, has become a commercial process due to the perfecting of a design of electric furnace in which an atmosphere of hydrogen can be maintained at will. The presence of hydrogen cleans the metals to be brazed, obviates the necessity of flux, and insures the flow of copper into the joints of the pieces to be united.

Plating has been given impetus due to the universal popularity of chromium as an exterior finish and to cadmium as a protective coating, resulting in the development of semi-automatic and full-automatic plating equipment, including that involving the use of integral conveyors.

In the process of magnetically controlled carbon-arc welding, by superimposing a strong magnetic field on the arc flame in the welding head, a control of the arc is established. The arc is given a gyratory motion of high velocity by rotating the carbon mechanically. A flux that forms carbon monoxide gas is mechanically fed into the crater to prevent oxidation.

Grinding continues to develop rapidly. The centerless type of machine is now being used on applications formerly considered entirely out of its field. Use of the center type is being extended. The grinding of castings is being carried out on a scale larger than ever. Grinding as a process is finding its way into the railway repair shop; it has met with wide reception in some shops, while in others it has been received not at all or reluctantly.

In the realm of heat-treating and metal forming, high-carbon, high-chromium die steels have met with great success in some quarters. The heat-treating of steel for pressed-steel parts has been selected as an outstanding development by a contributor representing a manufacturer of pressed-steel parts in large quantities. He says, "I think that the greatest advance likely to be found in the field of pressed steel is that of preliminary heat-treating of the steel itself in such a way that it is caused to be self-supporting through a great many operations where it was formerly thought necessary to entirely confine it between the surfaces of the dies."

The finishing of machinery is undergoing some change. Lacquer finishes are being applied in some instances. Color is being gradually adopted and widely considered. There is some speculation as to whether or not it is advisable for color standards to be adopted by the manufacturers of classes of machines. Certainly more thought is being given to the finish of machines, and labor-saving handling equipment is being introduced into the finishing operations.

Perhaps the influence of developments in other fields affecting machine-shop practice is best analyzed in the following quotation from one of the contributors to the data for this report: "The principal development in other fields of manufacture that have affected our own field relates to the increasing concentration of continuous production into fewer and stronger hands, and the insistent call for improved machinery created by this intensive competition."

Another contributor mentions the recognition of obsolescence upon the part of equipment users as an important development, which of course it is. That this matter of obsolescence is considered important in other fields is indicated by the action of the Department of Commerce in reaching the determination to undertake a study of industrial equipment to determine, among other findings, the amount of obsolete equipment and its importance as a factor in the inability of firms manufacturing similar products to compete on an equally profitable basis.

RESEARCH

Research has held a position of importance in machine-shop practice. The machinery industries are conducting a considerable amount of practical research upon problems with which they are immediately concerned, the stimulus being competition which calls for quicker methods of production or the substitution of cheaper materials on the one hand, and possibly more expensive materials with a smaller machining cost on the other.

It seems that much of the research by individual units of industry is undertaken merely to meet immediate conditions, and having satisfied those conditions, the results are lost to the industry as a whole. There is also evidence indicating that the engineering profession as a whole has yet to be educated to the fullest use of research libraries.

A.S.M.E. special research committees in the field of machine-shop practice have been active during the past year. The program of the Committee on the Cutting of Metals now includes:

a The collection and correlation of existing data on the cutting of metals, both in this country and abroad.

b An attempt by its Sub-Committee on Cutting Fluids to attempt the establishment of practical relations between physical and chemical characteristics of cutting fluids and their performance.

c The establishment of a test code for tool steels.

d Experimental investigation on the machinability of metals. (Engineering Foundation has granted $500 to this sub-committee for preliminary expenses in connection with the development of its program.)

To the Special Research Committee on Lubrication, Engineering Foundation has made a grant of $500 for the calendar year 1928 to aid in the development of its program to the point where it can call on industry for support. The proposed program includes a study of oiliness phenomena, the relation between design and bearing performance, and further experiments on the viscosity of lubricants at high pressure. The various phases of this investigational program are being carried on in the laboratories of the Westinghouse Electric and Manufacturing Company, the Bureau of Standards, and the Pennsylvania State College. The committee is now engaged in raising funds for the support of its program. At the 1928 Annual Meeting reports on the experimental work for that year were presented, on the effect of variations in the length-diameter ratios and clearance-diameter ratios on journal-bearing friction; also there was a paper on journal running positions.

About a year ago the Special Research Committee on Mechanical Springs employed a research associate at Union College, Schenectady, N. Y., on experimental work leading to the development of a reliable code of design for mechanical springs. A report of his work is being given at the Spring Session during the current Annual Meeting. As a result of personal calls on selected concerns made by various members of the committee, a complete picture of the research needs of industry in relation to mechanical springs has been made available. The Bell Telephone Laboratories, the U. S. Naval Experimental Station at Annapolis, Md., and some commercial laboratories are cooperating in carrying on certain experimental phases of the committee's research program. A bibliography of 600 references on the subject has been published for the Committee by the A.S.M.E. Funds collected to date amount to $5928.87.

Prof. Earle Buckingham, who has been directing the experimental program of the Special Research Committee on the Strength of Gear Teeth at the Massachusetts Institute of Technology, has recently completed an extensive mathematical analysis of a series of tests on gears previously conducted on the Lewis gear-testing machine. This study has been reproduced in a series of 12 progress reports which have appeared regularly during the past year in MECHANICAL ENGINEERING. The committee is now about to carry on a series of experimental tests on the Lewis gear-testing machine to check the accuracy of the analysis. Entirely new conceptions of gear-tooth action are foreshadowed as the result of this committee's work.

The activities of the Special Research Committee on Worm Gears have consisted chiefly in the collection from industry by various members of the committee of existing test data on worm drives and their action under various conditions. Professor Buckingham has applied his method of worm-wheel-contact analysis to these data and has developed a very extensive report

on his findings, which will be published later in MECHANICAL ENGINEERING.

Research to determine the design of shaper tools for greatest efficiency has been carried on at the University of Michigan. Results of some of these tests have been published (*American Machinist*).

Just a year ago the Machine Shop Practice Division organized a committee to determine projects for research. By members of this committee alone 62 projects have been suggested. For the most part these suggestions are worth serious consideration, irrespective of whether they are subjects to be undertaken by ourselves or by other societies or research organizations. The suggestions have been analyzed by the committee; some have been referred to other societies, and some have been considered as desirable for commercial investigation alone. Several have been recommended to the Division as worthy of immediate action and such recommendations have been indorsed by the division in transmitting the report to the Main Research Committee.

STANDARDIZATION

In addition to the standardization activities previously mentioned, the following codes and standards affecting machine-shop practice have been approved within the past year by the American Engineering Standards Committee:

a The Code for the Design of Transmission Shafting. This code includes rational formulas and diagrams for computing shaft diameters for all conditions of loading. It was approved in November, 1927.

b The tentative American Standards for Small Rivets and for Tinners', Coopers', and Belt Rivets were developed under the scope of the Sectional Committee on Bolt, Nut, and Rivet Proportions. These standards include material specifications and methods for testing.

c The American Standard Mathematical Symbols, which were approved by the A.E.S.C. in January, 1928, will do much toward the unifying of technical literature. It is one of a series of standard symbols being developed by the Sectional Committee on Scientific and Engineering Symbols and Abbreviations.

d The proposed American Standard on Tool-Holder Shanks and Tool-Post Openings has been approved by the Sectional Committee and is now being submitted to the sponsors for approval.

e The Safety Code for Forging and Hot Metal Stamping, which was sponsored by the American Drop Forge Institute and the National Safety Council. This code covers: "Drop forging and other hammer forging; including all hazards peculiar to the forging industry and associated with such machines, and whether or not they occur at the point of operation, but not including cold extrusion of non-ferrous metals, or hydraulic presses, except some small types of the latter; inclusion of hot pressing and bulldozing, and of other forging machines, such as bolt-heading and rivet-making machines."

f The Safety Code for Power-Transmission Apparatus has been revised and approved as an American Standard in 1927. The code covers: "Safeguarding of moving parts of equipment used in the mechanical transmission of power, including prime movers, intermediate equipment, and drive machines, excluding point of operation. This includes connecting rods, cranks, flywheels, shafting, spindles, pulleys, belts (except flat belts 1 in. or less in width or round belts $\frac{1}{2}$ in. or less in diameter), link belts, chains, ropes and rope drives, gears, sprockets, friction drives, cams, couplings, clutches, counterweights, and other revolving or reciprocating parts, up to but not including the point of operation."

Although the number of standards approved by the American Engineering Standards Committee during this period is not large, a group of projects has been undertaken recently which, when completed, will have a marked effect upon machine-shop practice. As one instance, the Sectional Committee on the Standardization of Small Tools and Machine-Tool Elements has undertaken the standardization of seven additional projects, beside stimulating the activity of its Sub-Committees on Tool-Holder Shanks and Tool-Post Openings and Machine Tapers.

It is gratifying to know that there is a constantly increasing favorable attitude toward standardization upon the part of manufacturers, and that the manufacturers are cooperating more than ever to bring about much-needed results.

OUTLOOK FOR 1929

By a group of men who represent a cross-section of the machinery industries, development along the following lines is expected during the coming year:

More universal use of nickel and semi-steel in iron castings

Improvement of die-casting material and increased use of die castings

Replacement of scraping by grinding as the predominant operation in finishing sliding surfaces

Development of cutting tools of greater capacity

Standards for the noses of lathe spindles

Wide adoption of integral-motor drive

Application of small conveyor and materials-handling installations

Still further general application of grinding

Use of higher-grade materials

Improved lubrication methods

More attention to rustproofing

Further application of anti-friction bearings

More hydraulic applications

Extended application of flanged motors

The use of larger chip pans on production machines

Production layout around materials-handling system

Solution of the problem of a standard taper for machine spindles and the shanks of small tools

More definite recognition of the economic drawback accompanying the use of obsolete equipment

Wider use of welding

More extensive replacement of castings and forgings by welded steel

Substitution of automatic machinery for hand labor

Reduction of stock on castings allowed for machining

Extension of piece work

More efficient training of apprentices.

Changes in the design of machine tools to be made necessary by expected changes in manufacturing methods that will be required on account of predicted changes in automobile design. The object of the changes in automobile design will be to bring about cheaper methods of manufacture.

Adoption of uniform cost-accounting methods by groups within the metal-working industry.

Greater recognition of the value of research. (According to a survey by the Division of Engineering and Industrial Research of the National Research Council, 187 "millionaire" manufacturing companies in the metal-working industries have an average yearly expenditure for research of $68,300.)

We may confidently look forward to much that will be new during the year 1929 on account of the stimulus that will be provided by the second National Machine Tool Builders' Exposition, to be held in Cleveland in September. The advent of 1929 finds machine-tool builders as a whole in very good position. They have enjoyed a year of business that has not been surpassed since 1920, and it may be expected that they will make every

effort, by way of design, to continue existing prosperity. Moreover, for some of them, foreign trade has been exceedingly good, and on that account makes its appeal for continued effort.

Activities of the Executive Committee of the Machine Shop Practice Division during the year 1928 have consisted of taking part in the Spring, Annual, and Boston meetings; conducting the Second National Meeting of the Division at Cincinnati; carrying on with the committee the activities of the special committee to determine projects for research; compiling the progress report; and issuing to the members of the Division a questionnaire, from the returns of which it is hoped may be made an analysis of the status of the mechanical engineer in the machinery industries as to position and salary. The effort required and the energy expended in these activities have been considerable, but the members of the Executive Committee feel well repaid by the appreciation of many members of the Division as expressed to them and to executives of the Society.

L. C. MORROW, *Chairman.*

Progress in Industrial Management

Contributed by the Management Division

Executive Committee: W. L. Conrad, *Chairman*, Park T. Sowden, *Vice-Chairman*, Geo. E. Hagemann, *Secretary*, Robt. E. Newcomb, W. R. Clark, and Wm. B. Ferguson

IT WOULD appear to be an undisputed fact that those in charge of the management of industry in this country are using every effort to bring about a change in the management of these industries so as to develop a sustaining prosperity. The older methods of management have apparently been entirely disregarded as obsolete, and present indications are that these methods will be replaced by principles of management based on facts rather than on theory or traditions.

Competition having become so keen that only those industries which are willing to accept facts as they exist can hope to survive.

There is a growing interest in the costing of marketing, and more specifically in the cost of marketing activities. This is a healthy condition and one that not only insures this particular activity but also will force industry to investigate all activities both of production and distribution. As J. P. Jordan in "Technique and Costing of Marketing Activities" says, "We haven't even scratched the surface of this subject as yet, but some interest is aroused and we are going to see a lot more of it in the course of two or three years."

A considerable interest is being manifested at the present time in Europe, and work along these lines is reported to have been accomplished in Poland, Germany, France, and England. In these countries progress is somewhat slower than in this country, and yet we look for a much more rapid increase in these activities in the very near future.

A renewed interest in investigation and research in practically all lines of industry shows that the industrial community is now searching diligently for a true basis on which we can build our future prosperity.

A considerable amount of research work has been accomplished along lines not necessarily classed as industrial. This is particularly true of engineering in homes, and the work accomplished by Dr. Lillian M. Gilbreth is particularly interesting in this direction.

The work of the Department of Simplified Practice in Washington under the able directorship of R. M. Hudson should be commended to all branches of industry, for it is accomplishing very far-reaching results which appeal to every leader of industry.

At the present time the selling and distributing factors are very closely allied with production in managerial problems, and both of these factors are taking foremost positions in the industrial world, and it is almost impossible to consider one without considering its relation to the other.

STANDARDIZATION OF OUTPUT AND EQUIPMENT

A marked change in attitude toward, and application of, standardization is evident both with relation to product and to the machines which make it. The old interpretation of standardization as something "fixed, unchangeable, and permanent" is passing out. Products are being revamped rapidly to meet new demands and an advanced conception by the public of what will most fully satisfy its wants. While many of these changes are external in their application, the tendency toward greater standardization of components is evidenced in the rapidly extending work of the American Standards Association (formerly the American Engineering Standards Committee) and its affiliated and associated bodies. This is strikingly demonstrated in present-day automobile design and construction.

Similar changes are being wrought in machine tools and other machinery of production. Standardization of components is being effectively employed in the fabrication of equipment capable of greater output per hour, and reduced operating cost.

There is quite a noticeable reduction in the variety of products manufactured in many lines, and this in turn has had a direct influence on the standardization of equipment. There has been a reversal of this condition in some lines where it has been found that the elements of style, color, or other variations are being demanded as a result of our growing consciousness and desire for individuality in our homes and personal effects.

The effect upon management where the variety of products is reduced has been to simplify their problems and make the total of their efforts just that much more effective. Increases in styles, colorings, etc., conversely, have increased the problems of management, although as a rule these changes are effected with little if any change in the manufacturing equipment. There is a definite tendency and desire to conserve all gains made in the standardization of manufacturing equipment, even at the cost of some inefficiency in the manufacture of items of limited demand.

There is an increasing amount of interest developing in industries in standardization of materials and parts. This is progress—and very profitable progress. The officials of one company have said that they spent quite a large sum of money in the years 1925, 1926, and 1927, and of course were continuing to spend good sums this year; but from the results that they had seen by the end of 1927, this expenditure would be returned to them in the year 1928 fourfold, based on the

same production as they had in 1927. Now, as their production is larger in 1928 by at least 25 per cent, the dividends this year, figured on the expenditure of the three previous years, will be about 500 per cent.

This having been accomplished by a company that was generally accepted as having more than average efficiency, we are certain that similar activity reflected by other concerns would be at least equally productive, and, in many cases, even more productive because of the new basis of efficiency from which to calculate.

ELIMINATION OF WASTE AND ITS RELATION TO COST

Manufacturers generally are waste-conscious, and progress toward the elimination of waste and the utilization of former wasted products is continuous, with corresponding continued reductions in cost. There is still much to be done in this direction, particularly in the production of materials that are subsequently converted into other products by other manufacturers.

In some plants the waste of every operation is weighed, and standard maximum percentages allowable at every operation are fixed in relation to the product. These percentages vary somewhat according to the product. Bonuses are paid to all employees for the reduction of waste, and this practice is carried out with very good results, even so far as paying executives on the same basis.

Standardization and research largely result in elimination of waste, and therefore in reduction of cost. One company established engineering standards for designers, tying them in with purchasing and manufacturing standards. This has reduced inventories of steel bars going into its products to 30 per cent of what they were before. This item of steel bars was only one of hundreds that were reduced to a greater or less degree by this standardization and research work.

Not only did this reduce cost, but it improved the product. The steel now being purchased by this particular company is purchased scientifically. The characteristics of steel needed for different purposes are first determined by research. Research also determines the proper heat treatments of each steel for each particular service to which that steel is to be devoted. The engineers were deprived of the liberty to specify at random the sizes that go into the designs and in this way the number of sizes of bars has been greatly reduced. All of these things of course affect costs favorably and also improve the product.

Many of our firms and corporations have conclusively demonstrated that waste elimination, as an important part of management's program, is the source of lower costs, higher wages, and better profits.

One of the most perplexing problems in connection with waste prevention, says the manager of the employees' service department of the Westinghouse Electric & Manufacturing Co. (in *Factory and Industrial Management*, September, 1928), has been to find a practical way to enlist the cooperation of employees, who, it was felt, did not in the main appreciate the value of the tools and materials with which they were working.

Two years ago a complete and systematic plan was evolved in this plant for the campaign for waste elimination. Each department was instructed to prepare exhibits of broken or damaged tools and materials, together with placards giving the costs involved, which could be transported through the shops. A bulletin was prepared to acquaint the employees with the purpose of the campaign and what it was hoped to accomplish.

While the actual gain cannot be measured in dollars exactly, one expert has stated that the saving in material alone amounted to at least $50,000, and it is felt that a much larger saving will eventually accrue from these activities.

The result of the campaign for waste elimination carried on by the Newport News Ship Building and Dry Dock Company during December of last year, is another outstanding example of what may be accomplished, and showed a very real connection with cost reduction. A "waste week" was designated during which all employees were urged to make suggestions regarding the possible elimination of waste. Out of a total of 2770 suggestions received there were 1482 separate concrete ideas. While only 677 have been officially approved, the estimated annual savings amount to $264,410.

REPLACEMENT OF OBSOLETE EQUIPMENT IN INDUSTRY

The general low average of earnings among our manufacturing industries, and the large proportion of available capacity that is idle, tend to encourage the continued use of equipment that in many cases is obsolete. This is reflected in the unsatisfactory condition of the machinery and machine-tool industry. There has been a definite and rapid improvement in this situation during the past few months, due undoubtedly to the improvement in earnings of concerns needing new equipment. There is still a vast amount of equipment of an obsolete nature, much of it being forced to produce the equivalent of modern equipment of similar type but at enormous cost for maintenance and repair.

It has been the practice of many concerns to spend a very respectable sum of money every year in the replacement of obsolete equipment, constantly seeking for methods which would improve the quality and hourly quantity output. We have a number of instances where the failure to do this has brought about failure in some cases, and the loss of profit in others.

The replacement of obsolete equipment is considered to be one of the principal factors in good management.

While no definite figures are available to measure the amount of replacement going on, and as there is no particular activity in the building of new plants, although there is always some of this construction in process, a very large part of the present demand for machine tools must be replacement demand rather than expansion demand. It is, as a matter of fact, understood that the machine-tool industry has had more orders in the first nine months of this year than it has in any period of nine months since the boom of 1919–1920; and the absence of boom proportions of new construction leads us to conclude that most of this demand is for the replacement of obsolete equipment.

The rate of replacement of obsolete equipment is apparently slowing down, although the process is continuing. By means of a questionnaire sent out this year, it was learned that the replacement policy of a group of representative American manufacturers contained this requirement: "New manufacturing equipment must pay for itself in from two years to three years to be considered a satisfactory investment." We are convinced this short term is gaining ground as an element of manufacturing policy.

An increasing number of investigations, surveys, and analyses are being put under way to determine the reasons for what is being called "profitless prosperity." Many of these investigations are showing that the owners of industrial plants are continuing to use obsolete or obsolescent machinery while they are paying themselves, their relatives, and friends exorbitant salaries. The broader economic and social viewpoint demands that improved equipment be introduced which will lower the costs of production in the businesses now using out-of-date equipment, and at the same time afford employment to men in the businesses making the improved equipment.

The matter of the replacement of obsolete machinery is now receiving wide attention throughout industry. Fred H. Colvin, writing for the June, 1928, issue of *Trade Winds*, says:

Many users of machinery tell you with a contented, if not supercilious, smile that their equipment is nearly all "velvet" because it has been charged off the books as depreciation. And they count their profits on this basis. The fallacy of this attitude is beginning to be appreciated by those who see competitors, because of their equipment of new machinery, underselling them and seriously encroaching on what they had considered as their own market.

The rapid improvement in machines of all kinds has made depreciation a very real factor in manufacturing accounting, and obsolescence now means far more than it did ten or twenty years ago for some. Some of the newer machinery turns out so much greater an output that the older machine, no matter what its condition, is a luxury that few can afford.

The best machines on the market determine the depreciation and obsolescence of those having a lower output.

H. P. Dutton, professor of factory management, Northwestern University, in an article appearing in the January, 1928, issue of *Factory and Industrial Management*, says:

Very recently, R. O. Eastman, Inc., completed for the publishers of *Factory and Industrial Management* a survey covering the purchases of industrial equipment and supplies by a group of representative manufacturers. The histories of several hundred purchases were obtained.

The expenditures for expansion of plants were almost four times those for the replacement of worn-out equipment; those expenditures called for by programs of modernization and improvements of existing plants were almost double the expenditures for current replacement. The leaders in industry are alive to the significant advantages of producing only with the very best possible tools. But the survey also revealed striking examples of apathy and lethargy on the part of highly respected organizations with regard to equipment purchases. For example, one company took eight years to buy a tool-register system. How much the company lost during these years, no one knows.

Distribution and Marketing of Product

General Technique. The best in this may be accomplished by discussing the fundamental principles underlying the costing of marketing activities. To promote discussion it may be well to suggest the following as a basis:

1 That expense accounts be provided for each main division of the general marketing expense such as general sales office, promotion departments, market research department, etc., and for each definite sales branch.

2 That every effort be made to allocate to the branches every possible direct expense, including whatever advertising and publicity activity can be regarded as applying to each branch.

3 That studies be made of the effort applied to certain important products or classes of products, not only in the branches but in the general department, to give a distribution to products of the marketing expense.

4 That statements of sales in total and also by-products be prepared for each branch and the business as a whole, with standard costs of product against each division group.

From these four items much can be got for real, active control of a marketing activity.

After all, the technique of accounting for the cost of marketing may be summed up as follows: Find out what information is necessary properly to control marketing activities and so reduce their cost; then get it.

Marketing of Product. A booklet just issued by the Department of Commerce points out the remarkable changes in merchandising that have come about in the last quarter-century as a result of mass production. It states that:

These changes have tended to upset methods of distribution which were deemed fixed and unalterable. Retail stores have increased rapidly in number, and their nature has become so changed that customers are uncertain whether to look for clothing in a haberdashery, a gasoline station, or a drug store. Some manufacturers do their own wholesaling and retailing. Retailers own wholesale establishments, and wholesalers own or control retail stores.

In any case the confusion which now exists does not simplify the problem of efficient business administration. Consumers, who usually have neither the time nor the inclination to study the problem, assume, as a rule, that the lowest prices offered are profitable to the seller and that any higher price is excessively profitable. Any situation which contributes to consumer distrust only adds to the difficulties of distributers. It is for this and other reasons that the Department of Commerce is concentrating its attention on the problems which affect our national livelihood so directly. More than 750,000 retailers each have sales less than $25,000 a year, and almost 150,000 manufacturers have a yearly production less than $100,000. In other words, there are in this country nearly a million individual business men whose volume of business seems hardly large enough to provide the facilities for the study of their several problems.

Some observers are already stating that these small businesses are on the way out. The great prominence given in the daily news to reports of mergers of manufacturing concerns and the growth of the chain-store movement have caused many to believe that the days of the small manufacturer and the independent merchant are numbered. After a very careful analysis of the situation the Department of Commerce can find no sufficient basis for this opinion. Many economists, too, have predicted that there will be a steady decrease in the rate of expansion of large business operations and a final stabilization at a point where both large and small businesses have found their plane of most economical operation.

The practice of mixing the functions of wholesaling, retailing, and manufacturing has introduced a confusion which makes most difficult proper analysis of the situation. When attention is directed to wholesaling it is discovered that its major functions cannot be dispensed with. The activities may be transferred into other hands, but the assembling and warehousing at convenient points must be continued, and the cost of doing it remains.

Manifestations of the experimenting which is going on merely indicate that the job of distributing commodities is being transferred from one head to another. The greater achievement will come in developing a new way, a more efficient way, of handling goods than in selecting some new agency to do it.

Studies which are being undertaken by the Domestic Commerce Division of the Department of Commerce are intended to reveal by the case method certain rules of operation which may generally be utilized by distributers performing the wholesale function, to the ends of more efficient services and reduced cost of operation.

Marketing Analysis. Market analysis as the basis for constructive planning in the marketing department of business is receiving more and more attention.

Dr. Harry R. Tosdal, in the volume on "Market Planning" of the "Manuals of Business Management," touches on several of the points where such planning may be used in the organization and operation of a marketing department.

1 The manufacturer may, on the basis of research, plan products which will be suitable for the market which he is trying to reach.

2 He may plan products so as to secure the favorable reaction of dealers and consumers toward the quality, durability, and style of the product.

3 He may plan to use the most effective selling points of the product on the basis of information obtained from the market.

4 He may plan to use his containers and methods of packing in such a way as to secure both safe and economical delivery and selling value.

5 He may use planning to determine the quantity to be produced and sold within a given period of each and all of the products which the company sells.

6 He may plan and schedule orders and deliveries in such a way as to provide fully for the needs of the sales department and of the production department.

7 He may plan his complete sales campaign in such a way as to bring about the coordinated and effective use of personal salesmanship, periodical advertising, dealer helps, and other means of selling, the districting of sales territories, and the routing of salesmen.

8 He may plan equipment for his salesmen.

9 He may plan quotas for territories, for salesmen, and for branch managers.

10 He may plan his advertising so as to secure the greatest benefit from it.

Sales Analysis. That the value of research, as a substitute for the intuitive method of determining business policies, is being more widely recognized can be seen in the report on the use of research in sales analysis, prepared by the Policyholders Service Bureau of the Metropolitan Life Insurance Company for the New England Council. In this report Champe S. Andrews, director of sales of the National Folding Box Company, New Haven, Conn., is quoted as saying: "I am unable to see how any sales manager can conduct his business without a searching analysis of sales which will bear reference to the budgeted activity of his plant, the profit made, and the relation this profit and activity bears to the efficiency of the salesmen producing the business. Selective selling is impossible without sales analysis. Sales analysis is at the bottom of successful selling."

PURCHASING OF EQUIPMENT

The most notable progress in purchase of equipment and supplies is in the use of technical specifications of purchases. Price is becoming educated to buy performance both in equipment and in supplies.

In the matter of economy in purchasing, a very distinct element is to discover, first, the best and not the cheapest, and buy on that basis.

A healthy present-day movement that is a decided contribution to better business practices is the allowing of fair profit to vendors as a strategic factor in the maintenance of source of supply.

A condensation of Lee J. Bussman's article in the June, 1928, issue of *The Purchasing Agent* is of interest in this connection.

> But such thoughts as shopping around, tight buying with tendencies to force prices down, and other evils laid at the purchasing agent's door are just a reflection of competitive business conditions as they are today, caused mostly by the fact that every one wants more business and will go to many extremes to keep production up.

With reference to the above, it is easy to see that the purchasing agent would rather go along doing business at a fair price with established sources. The members of the National Association of Purchasing Agents feel that the interview as reported in the New York *Times* some eight months ago, gave their position. One of the executives at that time, speaking for the members, said: "Experienced buyers know that the goodwill of the vendor is an important factor and that it cannot be had unless a legitimate profit is allowed.....It is poor business to be a party to a transaction where either side is going to lose money."

SIMPLIFIED PRACTICE

The work that is being accomplished by the Division of Simplified Practice, Bureau of Standards, is so far-reaching and beneficial to the industrial world that it commands the utmost admiration of all manufacturers and engineers, and the very great amount of work that has been accomplished in Commercial Standards is due, in a large measure, to the untiring efforts of Ray M. Hudson, the assistant director, whose work in this field of endeavor has resulted in a great saving, both of money and effort, in the many lines of activity in the industrial field.

As the work of simplified practice goes on and its application is broadened it is receiving wider recognition. Its principles of operation are better understood and the possibilities of benefit by its application are more generally accepted.

During recent months much interest has been shown on the part of the public in the manner in which the savings which are claimed for simplified practice are distributed. An editorial

PROGRESS FOR FISCAL YEAR ENDED JULY 1, 1928

Activities	As of July 1, 1927	As of July 1, 1928	Increase	Increase, per cent
Simplified-practice recommendations completed	74	95[b]	24	34
Acceptances, by trade associations	898	883[a]	....	...
Acceptances, by individual firms	6,676	9,754[a]	3,078	46
Projects based on requests for cooperation	596	623	27	5
Adherence by resurveys, cases	18	47	29	161
Percentage of volume of production	79	85	....	...
Adherence by industry's estimates, cases	4	12	8	20
Percentage of volume of production	84	80	....	...
Previously completed recommendations: Revised	12	24	12	100
Reaffirmed	17	42	25	147
Sales of printed recommendations	350,000	466,000	116,000	33

[a] Adjusted.
[b] Three of the projects reported as of July 1, 1927, failed due to lack of adequate producer acceptance, making the total as of July 1, 1928, 95. Percentage increase for completed projects is based on 71 as of July 1, 1927.

in the *Saturday Evening Post* of June 23, 1928, under the heading "Mr. Hoover's Savings' Account," closed with the following remarks: "Enough has been quoted from the statement of Director Burgess to indicate that the $300,000,000 referred to is no fanciful or theoretical figure. Moreover, it appears evident that this substantial sum is divided as it should be divided, among manufacturers, security holders, wage earners, and ultimate consumers."

To date 95 simplified-practice recommendations have been completed.

Surveys of the various industries to determine the degree of adherence to previously adopted simplified-practice recommendations indicate that 85 per cent of the acceptors, by volume of output, were adhering to the standards outlined in the recommendation.

Of the 43 projects now on the Division's active list, a large portion will no doubt be completed in the present fiscal year.

A general summary of progress for the past year compared with the previous year shows a 46 per cent gain in the total individual acceptances of simplified-practice recommendations, notwithstanding a readjustment of the figures to eliminate certain duplications previously carried. Also it is significant of the sustained interest in simplified practice that the sales of publications have increased 33 per cent. (See table above.)

TRAINING OF SALESMEN AND THEIR RELATION TO COSTS OF MARKETING

At first thought it may seem that of necessity a considerable gap separates the problem of training and the costs of training of salesmen for a life-insurance company from those which present themselves in the plants of the varying industries. Yet we venture to believe that it will be agreed that this gap is an imaginary and not a real one, and that the principles involved are identical with all. The place where the element of confusion might conceivably arise would be that in the case of a producer of merchandise—silk, soap, or food products—where there is a rather clear cost-finding system, making it possible to determine to a fraction of a cent the exact costs of production of the commodity. Furthermore, that cost-finding system is doubtless sufficiently comprehensive so that it is possible to estimate in advance almost the exact percentage of sales price which one would be warranted in setting aside for sales promotion, sales training, supervision, and other administrative costs.

The principles involved are percentages of costs extending over the entire transaction. If we are to face fairly the whole problem of training, its effects and costs, we must extend these effects and costs over a considerable period of time and include in them a sufficient number of sales to permit us to arrive at average results and figures in terms of percentages. If the whole cost of training were to be charged against every indi-

vidual sale, that would be one thing. But we are sure that we shall all agree that our problem presents no point of difference in so far as our desire is, by means of training, to produce a larger number of sales on the part of the trained man, involving greater satisfaction to both buyer and seller, as well as a lower cost when the cost item is distributed over a considerable period of time or a large number of transactions. Consequently we cannot but feel that in terms of percentages, both as to effectiveness and costs, our problems are identical.

Economical Management in Industry

There are so many instances of improvement in managerial methods that we certainly cannot doubt that there is continuous progress going on in this particular field. Increasing numbers of companies are making studies of various kinds that we might class under the heading of research in management.

Probably one of the most notable contributions of the year was the publication of the book by Wall and Dunning, "Ratio Analysis of Financial Statements." That work explains in detail a very valuable method of control that has been in use for some years, but has not spread very widely among financial executives, nor for that matter even among the larger credit men.

The ratios that constitute a good rule for the credit man to use in judging the credit title of an applicant are certainly very good ratios for judging the efficiency of management. It is obvious that a concern that turns out to be a bad risk is certainly not a successfully managed concern.

Modern principles of business management have been applied in many lines of industry. The usual method is by making a forecast of the year's business, and to base a budget upon this. Next a form of budgetary control is instituted, for it is known that if less money is spent than is received there would remain a profit. In other words, it has been found that it is possible sometimes to make more money with less business. We believe that this last-mentioned business principle is one which needs more attention. In the scramble to get a greater volume of business and to keep factories and mills running there has been a temptation to shade the prices until they cover bare costs—and sometimes less than cost.

The outstanding step forward in the economy of industrial operations during the past year is probably the inauguration of a carefully planned budget for all overhead expenses, as well as additional budgets on general and administrative expenses. The budgets are broken down to the point where every executive is in a position to measure the performance of his department in dollars. The budget figures are predetermined for a given capacity of operation so that the executive is in a position to prevent an overrun of his budget rather than to explain afterward why he overran.

Economical management in industry is best secured by records based on instant and automatic comparison of standard and actual costs, there being predetermined standard costs for every item of operating materials, of operating equipment charges, of operating expenses, both direct and indirect, as also of volumes.

The increase in exports, in the face of the rehabilitation of foreign industries and the raising of tariff barriers by them, is in itself evidence of the increased ability of American industry to compete successfully in foreign markets. Again considering American wages and material prices, and the profits, it is evident that this ability successfully to compete with foreign producers in their home markets is in no small measure due to economical and efficient management in American industry.

Review of exporting activities of the United States for the first half of 1928 shows the following "high lights:"

American houses did more foreign business in six months of 1928 than in any twelve months prior to 1926.

Thirty-three of our fifty leading exports for the period were finished and semi-finished manufactures.

Canada, which but recently displaced Great Britain as our best customer, increased its purchases nearly 6.5 per cent, buying $45.70 worth of American goods per capita for the six months.

Automobiles, parts, and accessories constituted 10.7 per cent of our total exports—the largest share of our export trade the automobile industry has yet attained.

Budgetary Control

F. Richmond Fletcher, of Scovell, Wellington & Co., says that the development of budgetary control and its increasing use among concerns in all kinds of industry is the outstanding feature in recent business management.

Ordinarily starting with a comprehensive budget of sales, based on past performance and a reasonably accurate knowledge of market conditions, potential business, and distribution, the budget requires a similar forecast of manufacturing facilities, inventory requirements, and the cost of manufacturing, of selling, and of administering the business for that proposed volume of business.

The logical development that follows is the establishment of definite standards for inventories and for material and labor requirements and costs, the proper determination and distribution of manufacturing burden and selling expenses, and the determination of the functional organization needed to carry out the program.

In concerns that have successfully carried out the principles of budgetary control, we find records and accounting practice that provide management with accurate and timely knowledge of all inventories, and of manufacturing cost and selling cost, with at least monthly comparative statements of all variations from the standards on which the budget was based.

Such a plan has invariably created a more intimate knowledge of plant and manufacturing facilities, of the capacity and the ability of men, and of the opportunities within the business for elimination of waste and for increased profits.

Budgetary control has also established a definite knowledge of the financing required to carry out the program, so that the monthly statements of actual in comparison with budget figures enable the management to adjust borrowing and financing to meet conditions.

Budgetary control also provides a most valuable indication of the trend in every activity and department of the business, so that management is conducted more scientifically and with greater assurance.

From actual experience and observation, we feel that successful business management, together with the proper financing of business enterprises, is dependent on a knowledge of facts and conditions; and we have seen nothing that provides this information in such useful and usable form as is exemplified in companies where budgetary control is in operation.

As in any form of constructive work, the development of budgetary control must be gradual and along definite lines. At the start it consists of a series of forecasts and estimates which are yet to be proved by actual results. It requires research and analysis, which in themselves frequently ferret out weaknesses and unnecessary waste, and provide better practices all along the line. It develops standards for foremen and department heads, so that they may compare actual accomplishments and see their own efficiency or inefficiency. Ultimately budgetary control brings all this into a condensed comparison of actual with budgeted results, from which the management can intelligently direct the business.

INTERNATIONAL MANAGEMENT CONGRESS

In reference to the International Management Congress, there is no question in our minds but that such a congress can be of tremendous value to all people and will be especially valuable to American manufacturers. It not only will tend to open up markets for American equipment but will also tend to stimulate American manufacturers to improve still further their own products through more effective management.

NEW DEVELOPMENTS

The development of L. P. Alford's paper of 1926 on "Laws of Manufacturing Management" into book form (this came off the press during September), and the preparation by Alford, in cooperation with Joshua E. Hannum, of a paper for the Annual Meeting of the A.S.M.E. on "A Basis for Evaluating Manufacturing Operation," will place in the hands of the industrial world a wealth of valuable data prepared in readable form that will be of inestimatable value to industry.

NEW SERVICE OF THE DEPARTMENT OF COMMERCE

The Department of Commerce is about to undertake a requested study of industrial equipment. One of the objectives of this study, which will be conducted by the Domestic Commerce Division, under immediate direction of H. C. Dunn, is to determine the amount of obsolete equipment and its importance as a factor in the inability of firms manufacturing similar products to compete on an equally profitable basis.

The Department feels that obsolescence merits a definite understanding, especially that it may not be confused with depreciation. The obsolescence of factory equipment is effected largely by style factors or by the new products of inventive genius, and not by wear and tear which are factors in depreciation. In discussing this work Dunn says:

> The practical value of this study would probably be a truer accounting for obsolescence as a hazard rather than an arbitrary compromise with depreciation as at present. Wear and tear, or depreciation, is a scientific measurement and can be determined accurately in cost accounting. Obsolescence is analogous to fire as a risk. It cannot be determined any more than the date a building will burn can be determined. An arbitrary basis of accounting for the two factors does justice to neither, and fails in adequately providing a fund for replacing machinery, when its value has been destroyed by its being worn out or rendered obsolete.

Further evidence of the widespread interest in this movement is evidenced by large volume of request for information on the subject, received by the Domestic Commerce Division, since the first announcement of its projected survey. Two nationally prominent trade associations are now entertaining plans for similar surveys in their industries to be made with the cooperation of the Department of Commerce.

TIME STUDY

There has been a pronounced tendency toward a better understanding of time study. The time session of the Chicago section of the S.I.E. attracted an attendance of 371. A committee was appointed for the purpose of standardizing time-study practices, and a study group was organized to meet once a week.

At the spring meeting of the Taylor Society in Detroit, time study was the outstanding feature of the program which attracted the most discussion and largest attendance.

At the 1927 Annual Meeting of the A.S.M.E., the time-study conference was very largely attended and characterized by questions and discussions which made it very evident that a large body of uninformed persons are interested in this subject. In fact, Carl G. Barth's remark that he felt we had to begin all over again and teach all the things that we taught twenty years ago in this field, was quite appropriate.

Walter C. Hasselhorn, supervising engineer, Stevenson, Harrison, and Jordan, of Chicago, states in *Manufacturing Industries* of September, 1928: "Time study is now recognized as an effective means of measuring employees' efforts, determining machine output, standardizing methods, stabilizing labor, controlling costs and increasing production or—to sum up in a single phrase—securing manufacturing betterment."

It is significant of the progress in management that "time-study" methods and technique are undergoing close scrutiny; and standards are being evolved, the application of which will insure more intelligent and effective use of this important tool of management.

INDUSTRIAL RESEARCH

Another feature of the past year has been the development of new materials and new processes as the result of industrial research. And further, more and more firms are taking up industrial research: to improve product or service; to reduce production costs; to develop new fields of application for products; to develop new materials and by-products; and to discover new products.

EFFICIENCY OF MACHINERY AND RESULTS

For several years the efficiency of the individual has been stimulated by better conditions, preparations, and reward. Recently this efficiency of the individual has been tremendously augmented by improved equipment, facilities, and straight-line movement of product during manufacture.

In the glass industry, hand-blown products are rapidly giving way to the machine-blown and machine-pressed products, because by the latter methods from 15 to 20 times as much can be produced in a given time.

In the steel industry, sheets and plates are being produced in an almost continuous process, from the melting of the ore to the finished product, with enormous savings in reheating and labor costs per unit of product produced.

By improving and rearranging equipment, much of the equipment is found to be unnecessary or is replaced by new equipment of new and more efficient design. This equipment is frequently so designed as to fit in with other machinery essential to the sequence of operations through which the product passes.

Especially in the case of fragile products, large savings in breakage loss are being effected through these straight-line and mechanical-handling methods, because the material is not subject to such violent and so frequent handlings.

W. L. CONRAD, *Chairman.*

A New Wood Preservative

WIDENING of the field in which treated lumber may be used to advantage is promised by a new wood preservative developed by L. P. Curtin, of the Western Union Telegraph Company, in an effort to find one for the poles of the company which would be less expensive than creosote and would not increase their electrical conductivity. This preservative, known as zinc meta-arsenite, not only does not increase the conductivity of the wood but does not reduce its strength as a structural material, as do zinc chloride and certain other chemicals used for wood preservation, and in addition does not affect its capacity to take and hold paint, nor does it have a corrosive effect upon metal with which it comes in contact. Wood treated with it is just as clean as before treatment when the process is carried out in a clean plant. The color of the wood is not changed.—*Engineering News-Record*, Dec. 6, 1928, p. 836.

Progress in Materials Handling

Contributed by the Materials Handling Division

Executive Committee: R. H. McLain, *Chairman*, M. W. Potts, *Secretary*, J. A. Shepard, G. E. Hagemann, F. D. Campbell, and C. D. Bray

PROGRESS in materials handling may well be likened to the progress of a river on its way to the sea. A change in a single plant, the introduction of a refinement in one of a thousand different devices, is like a ripple on the surface of the stream or an eddy in the current. Viewed from afar or by a hurried glance the river seems to be immovable, no change of course or speed or amount of flow. The same is true of materials handling; no survey of progress over so short a period of time as a year will reveal any startling disclosures. The shape of the stream is much the same as a year ago; its rate of flow has perhaps increased slightly, but not to any marked degree. There are, however, developments which, though not in themselves of far-reaching importance, indicate the trend just as a surface eddy indicates the process of erosion and the straightening of the river bed. The value of the specific illustrations in the following report lies therefore in their serving to illustrate slower, deeper movements which will become apparent only over a considerably longer period than one year.

Materials handling today may better be termed an industrial art than a science. Science connotes the existence of a universal terminology, an exact system of measurement and unmistakable definition as to conditions, methods, and results. This definition does not exist in materials handling today, nor does there seem to be any marked tendency in that direction. Little or no research (except by a few isolated manufacturers) has been attempted, hardly any theoretical material has been published, and any uniform or comparable methods of keeping transportation costs still await the efforts of the engineer or plant executive. That this condition exists is partially due to the attitude of those men from whom this Society draws its membership.

Of all the classes of men from whom information was sought for this report and which included manufacturers and users of materials-handling equipment, editors of industrial publications, executives of industrial associations, and men whose business it was to design and lay out industrial plants, the least information and the poorest response was received from the last named. The mailing list included the names of 62 engineering firms who either design, build, or act in a consulting capacity for industrial plants throughout the country. Of the 62 concerns questioned, 10 replied, and of these 8 stated that they were not familiar with the field or had nothing to report. One reply to the questionnaire sent last year arrived too late to be included in that report, but is quoted in part as an illustration of the point in question. The reply quoted is from an executive of a nationally known firm of consulting engineers and may be termed either humorous or pathetic, depending on the reader's point of view. "..... Inasmuch as we are only concerned with the design and operation of industrial plants, we are *naturally* not qualified to contribute anything to a report on materials handling." The italics are those of the Progress Report Committee, and if this firm is "naturally not qualified" the committee would like to know who would or should be. Aside from the above, the answers to the questionnaires provide a very real indication of the developments during the past year.

Before treating the development of particular equipment or the practices introduced in specific industries, mention should be made of the work of the Department of Commerce in the simplification of skid platforms and lift trucks. This project is more than a mere eddy on the stream of progress; it might best be likened to a dredging operation to straighten and deepen the channel, for by the removal of obstacles the usefulness of mechanical handling will more easily enter a new field. This field is that of physical distribution, which has in the past been neglected for that of production within the plant. As a special session of this Annual Meeting is being devoted to the subject, no further reference will be made here other than to say that the practice of skid shipment of material has grown noticeably during the past year, and that if any one development of 1928 is to be singled out as outstanding in its present and latent possibilities, this practice and the action sponsored by the Department of Commerce would in all probability be selected.

Approaching the subject of the development of different types of equipment, there are a few basic trends which, though applicable to all kinds of equipment, have been reported repeatedly in this field. Steel is replacing cast iron, pressed parts are being used in place of castings, roller bearings are more and more widely employed, while better lubrication, enclosed drive, and protective devices for machines and operators are becoming almost standard in the field.

In specific types of equipment the following developments are typical.

Bulk Handling

A new ballast-cleaning machine shown in Fig. 1 has been placed in service which operates with a much smaller crew, will clean wet ballast, and is so designed that the entire equipment is confined to the one track, allowing the free passage of trains on the adjoining track.

At Toledo a new car dumper has been installed which has a capacity of one 70-ton car per minute or 4200 tons per hour.

A process has been developed for the aeration of cement which permits it to be moved by force pumps without dust losses and with concurrent improvement in plant operating conditions.

To facilitate cheaper movement of equipment a prominent concern has produced a 2-cu. yd. shovel, grab, or dragline machine with caterpillar treads which are demountable for shipment, a narrow tread being laid on the flat car. This allows the large-capacity equipment to be shipped on flat cars without the expense of disassembling the unit. (See Fig. 2.)

Conveyors

The principal developments in conveyors have been along the trend toward "making on the move." Testing, weighing, assembling, and inspection are all carried out without the material's leaving the line; in many cases work-holding fixtures have been the means of accomplishing this end.

An improved design (shown in Fig. 3) has appeared for a roller-conveyor switch consisting of a special flexible section at the pivot end. Each roller on this section is separately mounted and kept in a radial position, with its own set of guard rails similarly mounted. Spur-gear drives in oil seem to be common in the newer types, while the application of conveyors seems to have

FIG. 1 BALLAST-CLEANING MACHINE WITH A CAPACITY OF ONE MILE OF TRACK PER DAY. FREE PASSAGE OF TRAINS IS ALLOWED ON THE ADJOINING TRACK

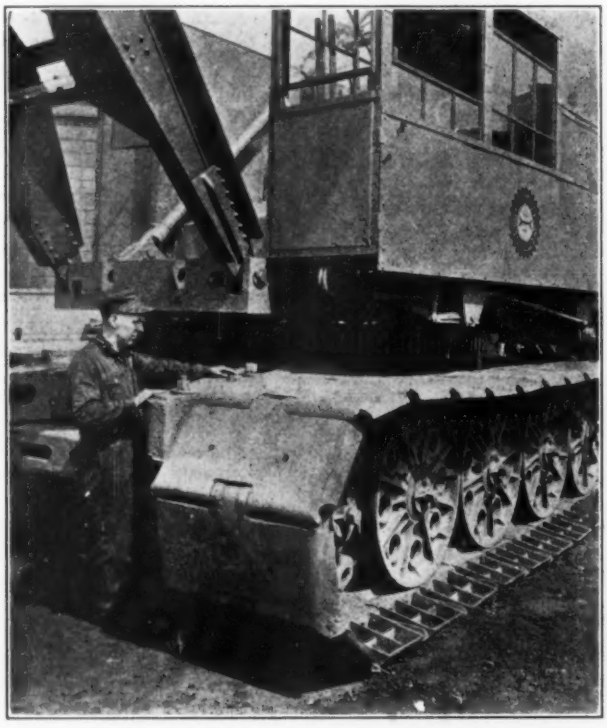


FIG. 2 A 2-CU. YD. CAPACITY SHOVEL WITH REMOVABLE CATERPILLAR TREADS WHICH ALLOW THE RAIL SHIPMENT OF THE MACHINE WITHOUT DISASSEMBLING

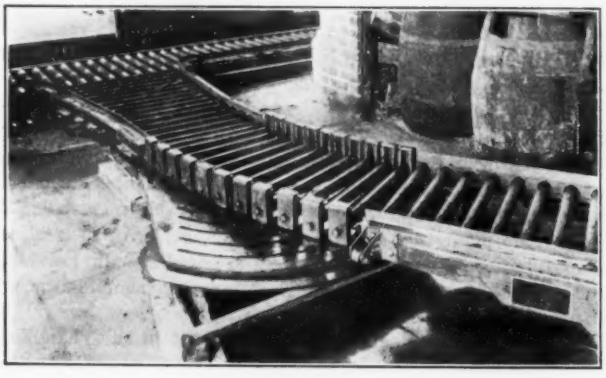


FIG. 3 PIVOT END OF A NEW ROLLER-CONVEYOR SWITCH

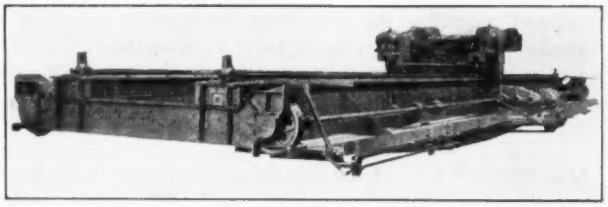


FIG. 4 OVERHEAD CRANE WITH WELDED-STEEL END TRUCKS AND EQUIPPED WITH ROLLER BEARINGS THROUGHOUT

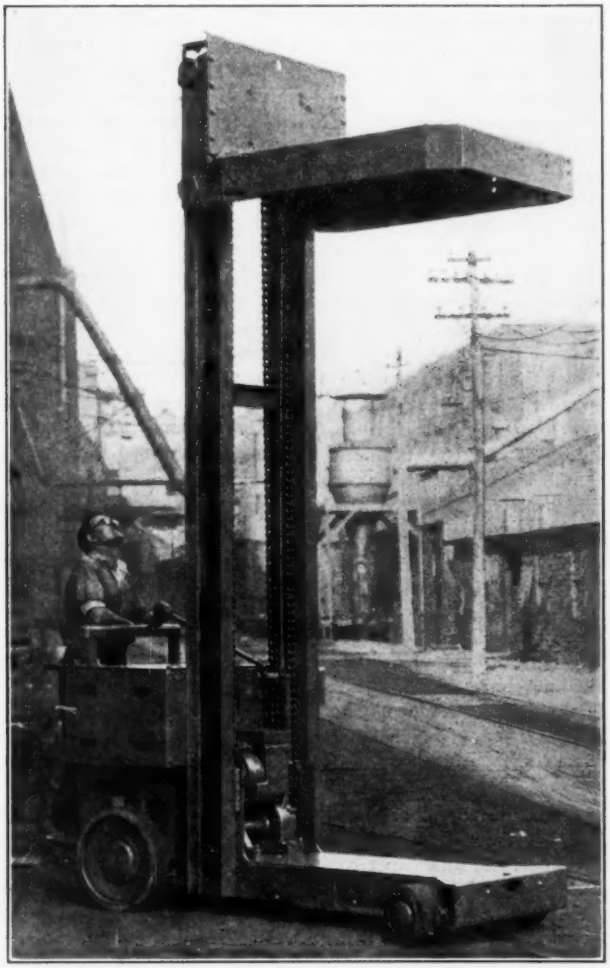


FIG. 5 6000-LB. HIGH-LIFT ELECTRIC TRUCK WITH LIFTING RANGE UP TO 11 FT. 6 IN.

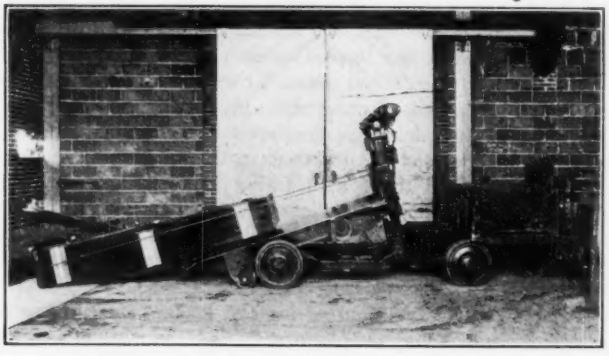


FIG. 6 TEN-TON-CAPACITY ELECTRIC TRUCK FOR HANDLING BUNDLES OF SHEET STEEL OFF THE FLOOR OF CAR OR WAREHOUSE

broadened generally. An interesting development is that in a Wyoming coal mine where the conveyor picks up the coal as shot from the working face, and transports it to the cars which are loaded in the main entries.

CRANES AND HOISTS

One company reports the furnishing of equipment for large wharf cranes which perform a spectacular task. These cranes transfer fully loaded refrigerator cars from the dock to the hold of a vessel. The process is reversed upon arrival of the ship at destination. The ships are to ply between New Orleans and Havana with perishable freight. Larger capacities are to be found in locomotive cranes, an 8-wheel 25-ton crane having appeared during the year. This crane also follows a growing practice by being powered with a 6-cylinder 150-hp. gasoline engine.

The design of cranes has followed the general trend in that welded steel has lightened the construction (Fig. 4), and more exact control is to be found from the use of Ward Leonard controllers instead of rheostats. Hook and travel speed have also increased during the year. There have been some interesting illustrations of the use of automatic grabs, particularly at the Hawthorne plant of the Western Electric Co. The use of men on the floor of their cable storage and testing room has been practically eliminated. The reels of cable are spotted in exact locations on the floor by means of depressions in the concrete which center the reels. The main crane runways are marked to correspond with the centerlines of the reels, and similar marks are used to center the carriage of the crane itself. The crane is equipped with an automatic grab so that the operator, having centered the hook over a certain reel, can pick it up without assistance from the floor. Reels are now stored with less than six inches clearance with the adjoining reel, and a large amount of storage space has been saved. Light hoists are being used in warehouses and the unloading platforms of large stores.

ELECTRIC INDUSTRIAL TRUCKS

Progress in the development of electric trucks has been along the lines indicated in previous years—larger capacities, increasing lift range, and the development of special equipment to perform some special task. Die-handling trucks have been delivered to such firms as Fisher and Briggs with rated capacities of 12 and 14 tons, some of which are equipped with supplementary winches for moving the die on and off the high-lift platform. A 6000-lb. high-lift truck which has a lifting range of 11 ft. 6 in. has been put in service in a paper concern. (See Fig. 5.) In the field of special trucks there are three which are of interest. A truck is now used by a sugar concern which cuts blocks of sugar from an 18-in. sheet, picks up five blocks weighing a couple of hundred pounds each, transports them to storage, and stacks the blocks. A second truck is one designed to handle bosch tanks in a tinplate mill. Lug angles were welded to the sides of the tanks which when loaded weigh about 9500 lb. These lugs are engaged by the lifting device which is in the shape of a divided platform, allowing the two halves to pass on each side of the tank. The top of the tank when raised comes in contact with a cover which eliminates all spilling of water while in transit. Another truck (see Fig. 6) which has been developed in connection with tinplate handling is used by the American Rolling Mills. This is a ten-ton articulated truck with tilting platform and auxiliary winch for the handling of bundles of sheet steel which rest on the floor of freight cars or mill. The bundle is loaded by inserting the edge of the platform under the bundle and drawing the load on to the inclined platform by means of the electric winch; the platform is then leveled before transporting the load. The process is reversed for unloading, the platform being tilted and the load released slowly by means of the winch.

HAND TRUCKS

The past year has seen the introduction of higher capacities, improved lifting devices, and other improvements. The use of live skids is coming into more prominence, while the practice of shipment on skids has increased the use of both hand and electric lift trucks.

Other fields have reported progress, though without any outstanding examples. The phase rectifier which allows the use of a two-wire pick-up of power instead of three has found application in the tramrail field. Another development in controls has been in connection with 18-ton dump cars which are used in a limestone quarry. These cars are moved, dumped, and returned by means of a distance control operated by one man.

INDUSTRIAL DEVELOPMENTS

Only a few developments in specific industries warrant particular attention, as there have been no outstanding changes in methods of either materials handling or other processes which would affect the former. Electroplating and heat treating in the automotive industry have increased the use of conveyor apparatus, as accurate control of the process is accomplished by mechanical handling. Work-holding fixtures are found to be more and more prevalent. Although not strictly in the materials-handling field, pneumatic systems are now employed in the chemical industry for the recovery of fumes that were formerly wasted. This practice has, of course, improved operating conditions in many plants.

The canning industry reports that the most outstanding accomplishment of the year has been the coordination of different types of materials-handling equipment with the resulting economies of properly chosen equipment for each process. The foundry industry has shown further adoption of continuous molding, which of course is not a new method, and it is probably not generally known that it was first used by the Westinghouse Airbrake Co. nearly forty years ago. Overhead tramrail equipment of new design (Fig. 7) is used for cupola charging, handling larger units, and providing an even distribution of the charge. Opinions differ as to the trend in the industry, some believing that surface transportation is gaining popularity while others hold that overhead systems promise greater economies.

One or two items are worthy of mention in the field of marine transportation. In addition to the handling of loaded freight cars in and out of the holds of vessels mentioned earlier in the report, more and more terminals are becoming fully equipped with mechanical equipment. The new terminals along the Pacific coast are better equipped to handle freight to and from motor-truck delivery. An engineer has also been employed by the shipowners and the stevedores along the San Francisco water front to study means of reducing accidents. Indications are already apparent that his services have been the means of making a radical reduction in the number of accidents along the piers. One authority in this field has stated that the biggest handicap to better handling methods in this field is the lack of sufficient accurate figures on which to determine the relative merits of different equipment and to judge the savings which would be effected.

The paper and pulp industry has continued in a prominent position as regards materials handling. The shipment of flat stock on skid platforms has grown during the year, the handling system is of prime importance in the design of all new plants, and attention has been given to the handling of miscellaneous materials around the plant such as coal, chemicals, etc. An interesting adaptation from another industry is the use of a pump for slush pulp which was adapted from those used in sewage-disposal plants.

The newer textile plants are paying more attention to handling

methods than ever before, and it is said by the technical editor of one of the leading industrial papers that there will probably be more handling equipment purchased in the next ten years than in the previous century.

Warehouse handling, though confined mostly to the chain-store and wholesale fields, has shown a healthy improvement over former years. The importance of economical handling has been driven home to the chain-store operators by the keen competition in the business.

In one or two instances the handling method has influenced the manufacturing process. The ability to handle large dies has changed the methods in the automobile-body business, while the methods used in locomotive and car repair shops have been revised so that the engine or car is stripped outside the shop, the parts cleaned, and the erection shop devoted solely to the assembling process. A new gas-electric locomotive is used by a steel plant for transporting "hot-metal" ladles from Hamilton to Middletown, Ohio, a distance of ten miles. The saving in the cost of reheating the iron has paid for the transportation equipment. Another development which should have a most lasting and beneficial effect is the practice of placing all transportation under the authority of one qualified man. This practice was at first confined to only the largest plants, but it has now grown so that the medium-sized and even fairly small plant has seen the economy.

Many of the answers to the questionnaires were couched in terms of generalities only, but these replies may well be used to summarize the basic trends of which specific developments are but the indications. In answer to what was the scope of development in the field, either technical, economic, or social, there were widely varying replies, as follows:

1 The extension of materials-handling methods into the distribution field
2 The coordination of the different types of equipment into a unified system for the plant as a whole
3 A growing acceptance on the part of plant executives that process work and handling are indivisible and often indistinguishable
4 That much had been accomplished in the development of special accessories for the equipment and in filling in gaps in the handling systems
5 That progress is in general due to the initiative of the manufacturers of equipment rather than the plant executive
6 That materials handling has raised the plane of the unskilled worker where mechanical means have been employed.

General trends in the equipment itself include the following:

1 The use of pressed-steel and welded construction
2 The introduction of roller bearings and better drives and lubrication
3 Larger capacities and improved controls.

RESEARCH

In reply to a question as to what research had been done in the field, the answers were in general in the negative, bearing witness to the fact that materials handling has not arrived at the stage of development where pure research is to any extent employed. In one of the large steel concerns, however, a materials-handling committee has been appointed to make periodic investigations as to the methods in the various company plants and those of other companies. A testing device, shown in Fig. 8, has been put in operation by a manufacturer of hand trucks and trailers. This is an example of practical research, and has probably been adapted from the "proving ground" idea common in the automotive field.

The Society for Electrical Development, Inc., has sponsored a field survey in which the entire question of the ownership of materials-handling equipment is a part. Fig. 9 shows the proportion of companies using different types of materials-handling equipment in their plants. It is interesting to note that the prevalence of the different types of equipment is very nearly proportional to the time such equipment has been used in industry; hand movement has of course existed since the beginning of time, and overhead cranes are one of the oldest types

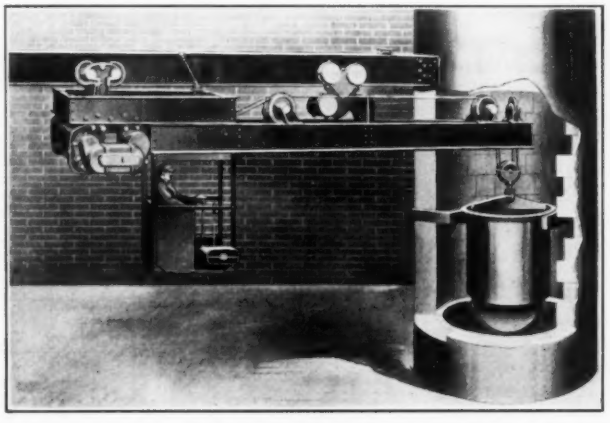


FIG. 7 MONORAIL CHARGING DEVICE FOR FOUNDRY CUPOLAS

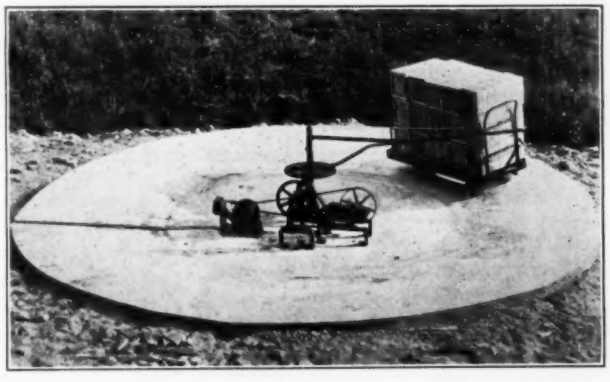


FIG. 8 A "PROVING GROUND" FOR HAND TRUCKS AND TRAILERS

of materials-handling equipment. Fig. 10 shows the proportion of companies engaging in each materials-handling operation. The high proportion found in operations (1) and (7) is undoubtedly due to the fact that many companies such as those having railroad freight houses and warehouses were interviewed in which these two operations embraced the entire activity of the plant. Fig. 11 shows the same materials-handling operations that are listed in Fig. 10 with the proportion of companies employing different types of equipment for these operations. The reverse of the curve for hand equipment might well be considered as an indication of the degree to which mechanical equipment has been employed in these various operations. It will be noted that the curve for overhead equipment and conveyors reaches a high point at operation (3), namely, the movement of material through process, whereas this same point is the minimum for the curve representing hand equipment. It should perhaps be realized that in the unloading of raw materials and in the loading of finished goods there is nowhere near the same degree of mechani-

zation, although every pound of material moved through process has to be handled when entering the plant and when some proportion thereof leaves the plant in finished goods. The problem faced by the materials-handling engineer and the manufacturer of

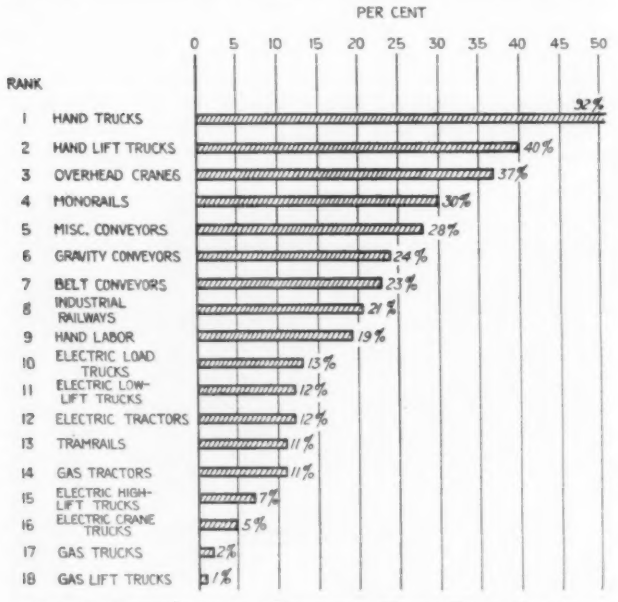

PER CENT
0 5 10 15 20 25 30 35 40 45 50
RANK
1 HAND TRUCKS 32%
2 HAND LIFT TRUCKS 40%
3 OVERHEAD CRANES 37%
4 MONORAILS 30%
5 MISC. CONVEYORS 28%
6 GRAVITY CONVEYORS 24%
7 BELT CONVEYORS 23%
8 INDUSTRIAL RAILWAYS 21%
9 HAND LABOR 19%
10 ELECTRIC LOAD TRUCKS 13%
11 ELECTRIC LOW-LIFT TRUCKS 12%
12 ELECTRIC TRACTORS 12%
13 TRAMRAILS 11%
14 GAS TRACTORS 11%
15 ELECTRIC HIGH-LIFT TRUCKS 7%
16 ELECTRIC CRANE TRUCKS 5%
17 GAS TRUCKS 2%
18 GAS LIFT TRUCKS 1%

FIG. 9 PROPORTION OF COMPANIES USING EACH TYPE OF MATERIALS-HANDLING EQUIPMENT

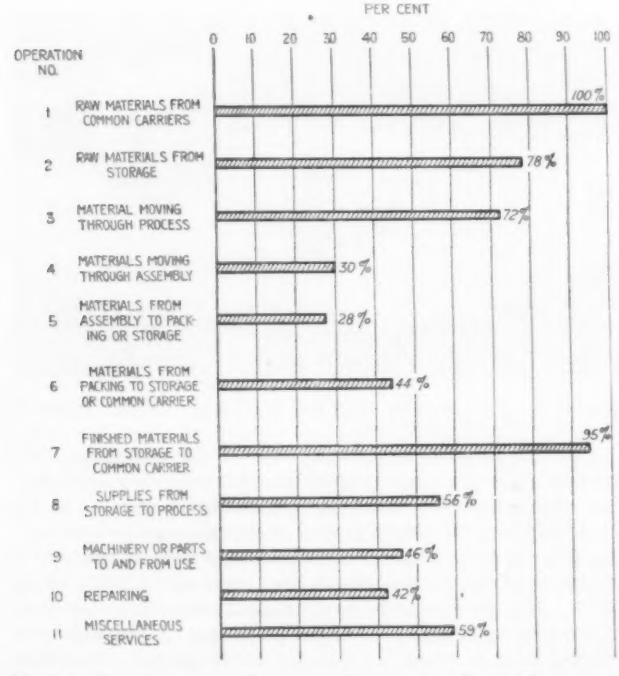

PER CENT
0 10 20 30 40 50 60 70 80 90 100
OPERATION NO.
1 RAW MATERIALS FROM COMMON CARRIERS 100%
2 RAW MATERIALS FROM STORAGE 78%
3 MATERIAL MOVING THROUGH PROCESS 72%
4 MATERIALS MOVING THROUGH ASSEMBLY 30%
5 MATERIALS FROM ASSEMBLY TO PACKING OR STORAGE 28%
6 MATERIALS FROM PACKING TO STORAGE OR COMMON CARRIER 44%
7 FINISHED MATERIALS FROM STORAGE TO COMMON CARRIER 95%
8 SUPPLIES FROM STORAGE TO PROCESS 56%
9 MACHINERY OR PARTS TO AND FROM USE 46%
10 REPAIRING 42%
11 MISCELLANEOUS SERVICES 59%

FIG. 10 PROPORTION OF COMPANIES ENGAGING IN EACH MATERIALS-HANDLING OPERATION

such equipment does not seem to be so much a question of the relative merits of different mechanical handling devices but rather an educational task to reduce the tremendous proportion of hand movement still existent in American industry.

Answering the question regarding the influence which other processes has on materials-handling methods, there were several factors which seem of real importance:

1 The growing decentralization of industry with the erection of plants in low-rent areas has led to a majority of one-story buildings with long hauls and more open location of machinery
2 Production machinery is being designed with an eye to the method by which the material will be brought to and from process
3 The handling methods of customers are influencing those in the plants of the suppliers of materials
4 The segregation of materials-handling costs has brought the entire question before the eyes of plant executives in the most forceful manner possible.

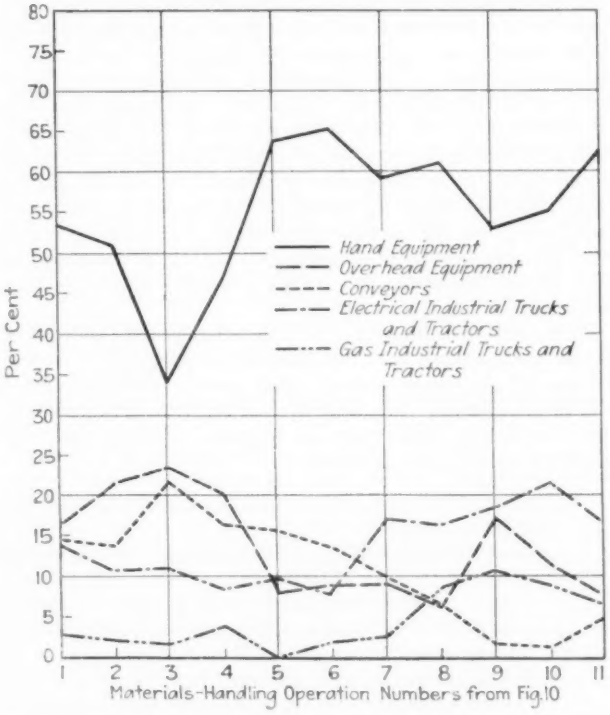

Per Cent
80 75 70 65 60 55 50 45 40 35 30 25 20 15 10 5 0
1 2 3 4 5 6 7 8 9 10 11
Materials-Handling Operation Numbers from Fig.10
Hand Equipment
Overhead Equipment
Conveyors
Electrical Industrial Trucks and Tractors
Gas Industrial Trucks and Tractors

FIG. 11 PROPORTION OF COMPANIES USING EACH TYPE OF EQUIPMENT FOR EACH MATERIALS-HANDLING OPERATION (DUPLICATION DISTRIBUTED)

The last question asked for an opinion as to basic trends, of which the following were most often mentioned:

1 The design of a new plant around the materials-handling method
2 The entrance of mechanical handling into the distribution field
3 The selection of equipment best suited to the particular service to be rendered, but with due regard for the entire system in the plant as a whole
4 The growing use of standard equipment wherever possible
5 The increase of hand-to-mouth buying has necessitated a speeding up of the flow of material through the plant
6 The full development of materials-handling methods seems to be a function of management rather than one in which the engineer, particularly the consulting engineer, is playing a leading or progressive role.

Respectfully submitted,
Progress Report Committee of the Division,
C. B. CROCKETT, *Chairman*
N. W. ELMER
E. D. SMITH
M. W. POTTS.

Progress in Oil- and Gas-Power Engineering*

Contributed by the Oil and Gas Power Division

Executive Committee: E. J. Kates, *Chairman*, L. H. Morrison, *Secretary*, L. M. Goldsmith, H. A. Pratt, and Harte Cooke

DEVELOPMENT in particular types of prime movers like oil and gas engines may be conveniently grouped in two phases: applications and technology. The new uses to which motors of this type are put give a good general indication of their commercial status and permit of estimating at fairly close range how great a factor they are likely to become in American industrial life. Technical advances in their design and operation are admittedly a step further removed from the world of commercial realities, but the laboratory specimens of today frequently become the commercial articles of tomorrow.

Economic Survey

Stimulated by a notable drop in the price per horsepower, general Diesel-engine sales, according to the most recent biennial census, have shown a marked tendency to increase. The enumeration for 1921 shows only 330 oil engines aggregating 89,039 hp., whereas in 1925 the American output had risen to 4101 engines totaling 409,390 hp. The 1921 census assigns $93 as the average value per horsepower, a figure which fell to $68 in 1923 and to $54 in 1925. A recent unconfirmed report states that during the summer of 1928, engines of a high-grade standard make were sold by the manufacturer at $45 per hp.

The strong recent trend toward the manufacture of small-unit Diesel engines is supported by the census, according to which 45 per cent of the engine output for 1925 was rated at less than 50 hp. per unit. In 1923, on the other hand, engines from 100 to 500 hp. were in the lead, with units from 50 to 100 hp. a close second.

Marine engines of all types for power-driven vessels under construction on January 1, 1928, show a decrease, as compared with the corresponding figure for January 1 of the preceding year, from 162,640 hp. to 99,200 hp. To what extent, if any, Diesel-engine construction participated in this sharp decline is difficult to judge, in view of the fact that a large number of installations are made in boats too small to be officially recorded. General indications are that yacht, tugboat, and workboat construction continues active, and that Diesel engines of moderate average size are being used.

There is a marked contrast between the development of the American marine Diesel engine and the European. Of the total tonnage delivered by American shipyards in 1926[3] only 15 per cent were Diesel-driven, and in 1927 this proportion increased by 0.5 to 15.5 per cent. The same two years show an increase from 30 per cent to 45 per cent in the proportion of American steam vessels to the total of American vessels constructed. In the world at large, on the other hand, the year ended in March, 1927, showed steam construction of 919,000 hp., substantially equal to motor construction of 918,000, while in March, 1928, the world's motor-vessel output had risen to 1,333,000 hp. and its steamship construction had fallen to 807,000.[4]

By all odds the greatest American user of marine Diesel engines is the United States Government with its fleet of 125 submarines aggregating 155,040 hp.[5] Great Britain possesses only 61 submarines, with oil engines aggregating only 92,400 hp.

The most recent announcement concerning the United States Shipping Board conversion program mentions eight Diesel engines close to 4000 hp. each, as listed in the following table.

Vessel	Engine builder	Hp.	Type
Galveston, *Oldham*	McIntosh & Seymour	3900	4-cycle D.A. 5-cyl.
City of Elwood, *Ward*	Busch-Sulzer Bros. Diesel Engine Co.	3950	2-cycle D.A. 6-cyl.
New Orleans, *Wichita*	Hooven, Owens, Rentschler Co.	4000	2-cycle D.A. 4-cyl.
Jeff Davis, *Porter*	Worthington Pump & Mach. Corp.	3625	2-cycle D.A. 4-cyl.

What promises to be a really significant innovation in naval engineering is the use of Diesel engines as cruising power for large war vessels. Although official confirmation is lacking, the British mine layer *Adventure* with 40,000 s.hp. in steam turbines will be fitted with Diesel engines for operation at cruising speed. The same applies to the 65,000-s.hp. battleship *Königsberg* of the German navy. The advantage of using Diesel engines for this purpose was recognized many years ago, but the present year gives the first indication of real activity in this direction.

Applications of the Diesel Engine

The use of Diesel engines for marine propulsion is likely to result in an upward revision in the speed of cargo vessels. No less than 20 motorships with sufficient power and speed to justify the accommodation of passengers are being commissioned for service between European and Californian ports (*British Motor Ship*, vol. 9, no. 102, Sept., 1928, pp. 203–204). Their speed ranges from 13½ to 14½ knots, which represents a substantial increase over the conventional 11 knots, or "economical speed" of the steam freighter. Recently the construction of 16-knot 10,000-ton "cargo liners" with Diesel propulsion was made the basis for the opinion that the economical limit of speed for the freight-carrying motor vessel has not yet been reached.

Reasons for the progress of the high-speed motor freighter are found in the fact that Diesel machinery is not subject to those specific limitations which have kept the speed of the steam freighter stationary at 11 knots during recent decades. Increase in the size of the steam power plant to give a speed exceeding 11 knots is out of proportion to the added advantage. On the other hand, the 11-knot Diesel power plant is of smaller size to begin with than the corresponding reciprocating steam plant. It can therefore be enlarged, with attendant increase in speed beyond 11 knots, while the well-known fuel economy of the Diesel engine permits still further increases before operating costs begin to balance the benefits of increased speed. The latter include about a 12,000-mile yearly increase in mileage. It is estimated that world motor-vessel construction averaging between 11½ and 12 knots exceeds 10½-knot steamer tonnage by 33 per cent. But if added carrying capacity based on greater speed is allowed for, the balance in favor of the motorship exceeds 40 per cent. There are strong indications that the use of Diesel engines for marine propulsion will bring about an organic structural change in the merchant shipping of the world.

In the application of double-acting Diesel engines to marine propulsion the most noteworthy innovation appears to consist

* References in the text are to the Bibliography given at the end of report.

in the use of speed-reducing gears between the engine couplings and the propeller shafts.[5] The 16,000-ton twin-screw passenger motorships *Milwaukee* and *St. Louis* under construction in a German shipyard are being fitted with four double-acting two-cycle M.A.N. Diesel engines of 12,600 hp. per vessel. To each propeller shaft turning at 110 r.p.m. are connected two Diesel engines of approximately 3200 hp. by means of gearing, the normal speed of the motors being 215 r.p.m. Because of their high speed the engines alone weigh only 600 metric tons per vessel; as additional advantages are claimed the fact that the space requirements are greatly reduced and that the low head-room needed for the engines permits of giving the upper decks of the ship an unusually favorable arrangement.

The use of Diesel engines for automotive service appears to be marking time, particularly in the United States. There is one manufacturer who has acquired a building license for an automotive-type Diesel engine, but instead of attempting to market the engine for use in trucks and omnibuses, he has semi-officially waived interest in these prospects and is marketing it for other applications. At least three prominent foreign builds of automobile trucks propelled by Diesel engines have recently been demonstrated in America, all without producing a single commercial result. Indifference to this apparently promising development is ascribed to a number of factors. So far the automotive Diesel engine has offered the truck and omnibus operator a solution for only one of his problems, and that is fuel cost. His large-scale operations generally enable him to buy gasoline at wholesale prices, which are estimated to be from 8 to 12 cents higher per gallon than the cost of Diesel fuel of a suitable grade. There is every prospect that the automotive market for Diesel engines will remain passive until some more radical changes are brought into view.

RAILWAY SERVICE

American rail cars numbering 143 units ordered since October 1, 1927, have been exclusively of the gasoline-electric type, according to a compilation kindly submitted to the Progress Committee by Marion B. Richardson, Secretary of the Railroad Division. One Diesel-electric locomotive of moderate power has been completed by the Baldwin Locomotive Works within this period, while the Ingersoll-Rand and General Electric Companies have cooperated with the American Locomotive Company in the construction of a total of 35 units to date, aggregating somewhat more than 10,000 hp. At the date of writing this report three or four of the locomotives are still under construction, but their delivery is expected shortly.

The application of oil engines to railway propulsion is still outstandingly characterized by the use of the electric drive, which requires that the capacity of the locomotive must be accounted for three times: in the prime mover, in the generator, and in the motors. Partly as the result of this there appears to be difficulty in reducing the weights of the units to figures capable of being reconciled with main-line railroading requirements. High first cost has also been a deterrent to the wider application of these units. According to Mr. Richardson, a Pacific-type locomotive developing 2900 hp. will cost not over $75,000, or $30 per hp., whereas until recently Diesel-electric locomotives of 800 hp. have been quoted at $160,000, or $200 per hp. Although this price differential of approximately 7:1 can be amortized by savings in fuel and increased availability, it is an item that cannot be disregarded in attempting to account for the slow progress of the Diesel locomotive in the United States.

Friction-clutch and hydraulic-gear transmissions as an alternative for electric drive on large units do not appear to have received commercial consideration in America, notwithstanding the fact that they appear to offer about the only possibility for relieving weight and cost difficulties. Lomonossoff[14] states that a geared Diesel locomotive is 30 per cent less costly than one with electric drive, and, under European conditions, costs only 50 per cent more than an equivalent steam locomotive. In a comparative test[15] made on the Russian National Railways between two equivalent locomotives, one with clutch-and-gear transmission and the other with electric drive,[7] it was shown that the former had a 10 per cent lower fuel consumption and performed 5 per cent more work.

One objection urged against mechanical transmissions with friction clutches is that they do not permit of starting a heavy train as smoothly as electric or hydraulic transmissions do. An explanation for this might be found in the somewhat abrupt transition between the dynamic and static coefficients of friction between the clutch elements. Up to the moment when the clutch begins to "take hold" the dynamic coefficient applies and immediately thereafter a static coefficient of considerably higher value replaces it. Jerky starts are reported, with attendant damage to draft gear and rolling stock.

For the present it appears as though the hydraulic transmission is "out of the picture." It is necessary to distinguish here between the ordinary form of transmission involving the use of a variable-capacity pump with constant-displacement hydraulic motor (Lentz), and the differential hydraulic gear devised by Heinrich Schneider.[9] If it were not for the latter, it might be said that the low efficiency, heating, and limitation to low capacity would account sufficiently for the present neglect of the hydraulic principle. In the Schneider differential hydraulic gear, however, these drawbacks are not present. In "full gear" this transmission does not depend upon the flow of liquid, as the displacing members are locked against a static pressure and the drive to the locomotive axles takes place without pumping oil under pressure and the hydraulic losses incident thereto. The efficiency of the Schneider gear therefore reaches its maximum at full speed (above 92 per cent), while its efficiency is still comparable with that of the Lentz gear while working at high torque and low speed. As the Schneider gear is not subject to heating on account of hydraulic friction losses at full speed, there is no tendency to vaporize the oil and cause "gas binding," a difficulty which is reported to limit the Lentz gear to a capacity of about 300 hp. On a purely technical basis it is therefore impossible to account for the present neglect of non-electrical transmissions in general and the differential-hydraulic gear in particular. At the same time the electric drive appears to have reached a stage beyond which little progress is in sight at this writing.

The Kitson-Still oil-steam locomotive[10] has made several trial runs while pulling trains of cars weighing up to 118 tons. The compressed-air-transmission Esslingen Machine Works locomotive powered with a 450-r.p.m. 6-cylinder M.A.N. engine is still reported as incompleted.[10]

A really new application of the Diesel engine that is commanding widespread interest is found in the Stinson-Detroiter monoplane flown on September 19, 1928, with a 200-hp. 1800-r.p.m. 9-cylinder radial air-cooled airless-injection motor for the design of which Prof. Hermann Dorner is said to be mainly responsible.[11] The technical features which have apparently lifted this machine out of the general run of high-speed Diesel engines and made possible its use for aeronautical purposes are treated later in a section of this report. The engine was built by the Packard Motor Car Company, whose aeronautical engineer, Col. L. M. Woolson, is said to share the credit for the development with Professor Dorner.

Although there seems to be no marked trend in the United States toward the use of Diesel engines for agricultural tractors, heavy excavating machinery continues to be powered with this type of motor.[12] As the latest striking example of this may be

mentioned a Marion Steam Shovel Co. excavator driven with the help of electric transmission by an 180-hp. Winton Diesel engine.

The second double-acting engine of American design has been tested at the plant of the Sun Shipbuilding & Dry Dock Co.[22,23,24] It was built under patents originally granted to H. R. Setz, deceased, and is characterized mainly by novelties in the construction of the cylinders and framework and by a method of scavenging that depends on the use of individual automatic valve groups placed directly before each cylinder port. In view of the satisfactory results obtained from the first 3-cylinder engine of 16 in. × 22 in. bore and stroke, developing 690 b.hp. at 180 r.p.m., designs for larger units have been laid down.

COMPETITIVE STEAM POWER

There are three developments in steam-power engineering which are considered as possibilities for reducing the Diesel engine's competitive margin of economy. They are the Bauer-Wach exhaust-steam turbine,[13] the Caprotti valve gear,[14] and the internal-combustion boiler.[15] The economy of triple-expansion marine steam engines has been put on a basis thoroughly competitive with many Diesel installations by passing the steam from the l.p. cylinder through a low-pressure turbine attached by means of gearing and a Föttinger hydraulic clutch to the propeller shaft. In the case of the Steamer *Boniface* thus equipped the water rate at 300 i.hp. was reduced from 14.22 lb. to 10.75, while a mean fuel-consumption rate of 1.5 lb. of coal per i.hp-hr. was recorded. The outstanding feature of the Caprotti valve gear as applied both to marine and locomotive engines is found in the use of poppet valves and a simplified valve gear for actuating them, the combination making possible cut-off regulation at full steam pressure and the adjustment of inlet and exhaust events independently of each other. Notable reductions in the fuel consumption of steam locomotives are credited to the arrangement. Finally the internal-combustion boiler as fired with gas fuel has developed boiler efficiencies well above 95 per cent. Should it be possible to extend this development in such a way that fuel oil could be used in the boiler, it might ultimately have an important bearing on the economy of non-condensing steam engines such as are a part of every reciprocating steam locomotive. Its importance is considered to be less from the point of view of condensing steam plants, as the presence of appreciable quantities of gas in the condensate obviously interferes with the maintenance of a suitable vacuum.

Increases in the efficiency of more standard forms of marine power plants typified by the Parsons high-pressure steam turbine (*The Engineer*, Sept. 17, 1926, p. 296) as installed on the S.S. *King George V* and in the *Beaver* type of Canadian Pacific ships have not as yet demonstrated their ability to make serious competition for the motorship. Two and a half years ago Sir John Biles (*Shipbuilding and Shipping Record*, April 2, 1925) gave forcible expression to the hopes of the steamship builders of the world by dwelling on the progress in steam engineering which the development of the Diesel engine had stimulated, intimating that the ascendancy of the Diesel engine would be only temporary. Since that time, as pointed out in an earlier paragraph of this report, steamship construction has been outstripped by motor-vessel building, and the possibilities of a reversion to the steamship's old predominance are not considered imminent.

TECHNOLOGY AND RESEARCH

Advances in Diesel-engine technology now appear to be centering largely about the control of combustion, in view of the generally accepted fact that advanced methods of design and manufacture have conquered specifically mechanical problems, such, for instance, as bearing maintenance. Nearly all components of the Diesel engine outside of the combustion space have been perfected to an apparently satisfactory degree as the result of advances in general mechanical technology characteristic of the age in which we live. Whatever residuum of general mechanical problems may still remain appear to be dwarfed in comparison with the difficulties still experienced in bringing about the ideal chemical combination of oxygen and fuel in the combustion space of the Diesel engine. As exceptions to this generalization may be mentioned the fuel pump and the high-speed engine piston, but they are not considered to present problems equal in importance to those of combustion.

If this view is accepted, the most encouraging report on the technological development of the Diesel engine in America is the one prepared for the O.G.P. Progress Committee by Wm. F. Joachim, senior mechanical engineer of the Langley Field Laboratory of the National Advisory Committee for Aeronautics, under the authorization courteously extended by G. W. Lewis, Director of Aeronautical Research. Mr. Joachim's statement merits verbatim quotation:

> A considerable amount of additional theoretical and experimental research on the aircraft oil engine is in progress at the Langley Field Laboratory of the National Advisory Committee for Aeronautics. The work includes investigations on oil sprays with the N.A.C.A. spray-photography equipment; complete fundamental physical and thermodynamic analyses of the major factors controlling the hydraulics of injection systems, ideal oil-engine-cycle efficiencies, oil-spray and cylinder-air mixing rates, and combustion; and engine tests with precombustion and integral-type combustion-chamber cylinder heads.
>
> The spray-photography equipment has been used to determine the velocities of hydraulic pressure waves in an injection system operating at high speed. Various lengths and bores of injection tubes, initial injection-tube pressures up to 5000 lb. per sq. in., injection pressures up to 10,000 lb. per sq. in., and injection-valve opening pressures up to 5000 lb. per sq. in. were investigated. The important effects of air turbulence on the penetration of oil sprays with time and on other characteristics were also studied. Design work is under way to facilitate studies of the independent effects of pressure, temperature, air turbulence, and gas dilution on the ignition and combustion of oil sprays with this equipment.
>
> The largest advance in engine performance this past year has been a radical lowering of the maximum cylinder pressures. A N.A.C.A. single-cylinder Universal test engine, with a standard Liberty aircraft-engine piston, connecting rod, valves, and other parts has been successfully operated as an oil engine at speeds up to 2400 r.p.m. with good performance. Extended tests at 1500 r.p.m. have been made, the b.m.e.p. with no excess air being 110 lb. per sq. in. with a brake fuel consumption of 0.50 lb. At this same engine speed and 38 per cent excess air, the b.m.e.p. is 96 lb. per sq. in. with a brake fuel consumption of 0.44 lb. The cylinder pressures were 675 and 700 lb. per sq. in., and the corrected mechanical efficiencies 85 and 83 per cent, respectively.

Pennsylvania State College reports progress in the preparation of its laboratory devoted to oil-engine spray research, although it is too early yet to look for results.

COMBUSTION RESEARCH

The quantity of fundamental research on oil sprays and combustion that is going on in Germany is several times as important and voluminous as that carried out in most other countries. What promises to be the starting point for an entirely new technology of Diesel combustion is the study of Dr. Sass[16] on "Ignition and Combustion Processes in Diesel Engines,"[17] which establishes (*a*) that the liquid droplets of fuel sprayed into the combustion space of a Diesel engine ignite directly without being previously vaporized, and (*b*) that the oxidation of the fuel into CO_2 and water is preceded by the formation of a large number of oxygen compounds which are stable only over limited ranges of temperature and pressure and whose break-up constitutes the combustion process proper. It is expected that the realization of these facts will have an important bearing on matters of urgent practical import, such, for instance, as the behavior of various

types of fuels in precombustion-chamber engines and the possibility of standardizing fuel specifications.

Additional data on fuel combustion are reported in connection with the determination of the effect of oxygen concentration on the ignition of liquid fuels.[18] It is reliably indicated that the more complex hydrocarbons have ignition points that vary with oxygen concentration according to laws different from those which determine the variation of ignition points in the simpler compounds.

Considerations involved in the substitution of constant-volume for constant-pressure combustion in Diesel engines of the automotive type are analyzed by Professor Neumann,[19] who reaches conclusions apparently favorable to constant-volume combustion. Although the greater part of his analysis is mathematical, he includes in it an exhaustive test of an automotive engine with plain combustion space designed by Prof. Hermann Dorner, an engineer who is reliably reported to have designed the nine-cylinder air-cooled radial aeronautic Diesel engine of the Packard Motor Car Company flown on Sept. 19, 1928.[11] The Dorner engine tested by Professor Neumann corroborates the mathematical deductions applying to the non-conducting engine with constant-volume combustion. Actual test results show the attainment of 99.5 lb. b.m.e.p. at 1000 r.p.m. with an excess-air coefficient of only 1.21 and an exhaust temperature of 1056 deg. fahr.

It is stated that the results from this constant-volume airless-injection high-speed automotive Diesel engine are in all respects comparable with those obtained from a standard air-injection machine of conventional stationary design. As an additional phenomenon of cardinal importance for high-speed work attention is called to the results of the variable-speed tests, which indicate that up to a certain speed the air volume effectively participating in combustion increases, despite the falling-off in volumetric efficiency. The improvement is ascribed to the added turbulence of the air charge that results from its introduction into the cylinder at higher velocity.

Whereas the foregoing applies to high-speed Diesel engines with open combustion spaces, equally startling results are reported for machines of the precombustion-chamber type.[20] According to Professor Neumann, precombustion takes place in the chamber with a considerable excess of air, notwithstanding the fact that until then scientific opinion had been unanimous in regarding the preliminary combustion as being air-starved on account of waste gases having remained in the chamber from the preceding combustion. Calculations have been made to show what the rate of air inflow to the chamber is at the moment of injection, while the rate of travel of the fuel spray through the chamber and the neck is such as to leave less fuel in the chamber than can be consumed by the available air. With a speed of 520 ft. per sec. calculated for the spray, the time available for combustion within the chamber of the engine under test is stated to be only 7×10^{-5} sec., alleged to be only $^1/_{100}$ as long as would be necessary for ignition. Such combustion as does take place is ascribed to the fringes of the spray, which are regarded as not passing through the neck and which bear the ratio of 1:1.46 to the available air. A general conclusion reached in regard to the precombustion-chamber engine is that it is advantageous for high-speed Diesel-engine work because it affords the means (high temperature of the chamber walls) for rapidly heating the atomized fuel and for subjecting it to energetic turbulence.

THE COAL-DUST ENGINE

The coal-dust Diesel engine now seems to be a reality.[21] A single-cylinder air-injection engine has been operated regularly for 12 years on powdered coal from Upper and Lower Silesia, also on lignite coal dust from central Germany, Silesia, and Bohemia; finally on wood grindings, charcoal dust, rice-hull dust, and even with the dust of metallurgical coke. The machine is rated at 80 hp. with 160 r.p.m., and has bore-and-stroke dimensions of 16.54 × 24.8 in. It is regularly used for driving a machine shop of moderate size. The exact method by which the coal dust is fed into the cylinder is not disclosed,[22] the only statements published in regard thereto being that the governor controls the quantity and that either injection air or a pressure wave due to precombustion in the coal-storage antechamber serves to inject the dust. Reproductions of indicator diagrams having a definite and well-defined shape are published.

GAS-ENGINE PROGRESS

A notable development in the gas-engine field is reported to the Committee by G. W. Struble, vice-president of the Bethlehem Steel Company, who mentions two 47-in.-84-in. × 60-in. gas blowing engines embodying the Bethlehem scavenging and supercharging system. Each is rated to deliver 5400 b.hp. at 80 r.p.m. and has been in operation since January, 1928. In addition five single-crank gas-driven blowers of the same cylinder size aggregating 13,500 b.hp. are under construction with the same features as the 5400-b.hp. units.

The Bessemer Gas Engine Company reports a "gas economizer" which embodies a system equivalent to supercharging a two-cycle gas engine by means of natural gas under a pressure which is varied with the load from about 7 to 15 lb. per sq. in. Apparently the displacement of exhaust gases from the working cylinder is accomplished by fresh air rather than by mixture, whereupon a mechanically operated valve admits a charge of gas during the compression stroke before enough compression pressure has been built up to oppose it.

Gas engines for lighter-than-air craft have been brought into prominence by the flight of the dirigible *Graf Zeppelin*, which is propelled by five Maybach engines consuming what is known as "Blau gas." Whereas engines operating on gas fuel do not come into immediate question for the propulsion of airplanes, they are likely to achieve importance for dirigible work on account of some special aeronautical considerations which are involved. When liquid fuels are employed, the buoyancy and often the trim of the vessel is apt to be changed as the supplies of fuel are consumed, while corresponding amounts of hydrogen, or the much more valuable helium, must be valved. On dirigibles with liquid-fuel motors it is therefore proposed to condense the water vapor in the exhaust and to retain the water vapor aboard the ship in order to avoid waste of lifting gas. The extra weight and equipment of the condensing equipment is, of course, objectionable. But when engines running on Blau gas are used no buoyancy correction is required, for the reason that this fuel gas has a specific gravity of approximately 1.08 compared to air, and as the space occupied by it becomes filled with air the buoyancy and trim of the ship are not affected seriously. Blau gas is obtained from petroleum by what may be termed a cracking process not unlike that used in the manufacture of Pintsch gas. Similar fuel possessing adequate calorific value and suitable specific gravity is also obtainable partly from natural wells in the United States.

CONCLUSION

The foregoing report is considered to offer a basis for the general opinion that the commercial development of the oil engine in America is proceeding at a rate not markedly different from that of previous years. Research activity by the N.A.C.A. is well up to the standards both for quality and quantity that can be fairly set for any single agency, but outside of this there is little to report in the way of research progress on American soil. The inference is not that American engineers are any less able than their European colleagues, but that the unprecedented prosperity

of industry probably takes away some of the incentive for developing a product which has economy as its major justification. It is therefore not improbable that features other than economy which make the Diesel engine sought after, such as reduction of fire risk in aircraft and an increase in aeronautic cruising radius, will shortly provide the stimulus which the European finds primarily in more stringent economic conditions.

JULIUS KUTTNER, *Chairman*,
Progress Report Committee, Oil and Gas Power Division.

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Progress in Hydraulics

Contributed by the Hydraulic Division

Executive Committee: Ely C. Hutchinson, *Chairman*, H. L. Doolittle, *Secretary*, R. L. Thomas, W. M. White, and L. F. Moody

THE progress report of the Hydraulic Division for 1927, submitted by Mr. Ely C. Hutchinson, was a comprehensive survey of the hydraulic field. Since the preparation of that report there have been no outstanding new developments or trends in machinery or methods, and few changes in practice. The intervening period has, however, witnessed intensive and successful effort along several of the lines of development noted last year, and particularly an increased striving to approach the goal of perfection in economy of design and operation. Hence this year's report must be in large part a follow-up or bringing up to date of last year's report.

This condition is to be expected, as in the nature of things progress in hydraulics is slow as compared with that in some other branches of engineering, as, for example, steam-power generation. Hydraulic machinery of many types has reached an advanced stage of development. Theoretical maximum efficiencies have already been closely approached in the turbine field, recent reaction-turbine tests having shown efficiencies up to 94 per cent, although there is a larger margin for improvement in part-gate turbine efficiencies and in pumping equipment. Also changes must come rather slowly, as several or often many years are spent in the preliminary study, design, and construction of hydraulic works.

It seems to be a fact that there has been a slowing down of water-power development in the United States, although the same cannot be said of Canada, which in relation to demand is more richly endowed with low-cost water-power sites which do not have to compete with cheap local fuel supplies. The past year is notable for the important hydraulic-power plants which were put into operation, but these have been in the making for several years and are more or less familiar to hydraulic engineers. In spite of unusually favorable financial conditions, comparatively few important projects have been undertaken recently in the United States. This slowing down has been ascribed to two

causes or groups of causes: first, political agitation and governmental interference or indecision, extraordinary taxation, and the withdrawal of some of our most important rivers and sites from the provisions of the Federal Water Power Act; and second, the economic condition brought about by the decreased cost of steam-generated power and the previous development of the cheapest and most accessible water-power sites. Also it is believed by some that the falling off is temporary, as the industry has always been subject to periodic fluctuations.

Economics of Hydraulic Power

The outstanding recent trend in the hydraulic-power field is economic rather than mechanical; that is, the best efforts of power engineers, manufacturers of equipment, and users thereof are being devoted to lowering the cost of water-power development, improving the economy thereof, and working out the best economic use of water power in coordination with steam power. With the growth of interconnection, the all-hydroelectric generating system is becoming a thing of the past in the United States. The combination of hydro and steam power makes possible the economic justification of many otherwise impracticable water-power projects. Formerly it was possible and customary to justify a hydro development, particularly a run-of-river project, in comparison with steam power by evaluating the operating replacement cost of the equivalent steam-generated energy, or often the saving in fuel cost alone. This is no longer possible on account of the great advances in the economy of generation at steam-electric plants. As the efficiency of hydraulic-power generation has already approached the theoretical maximum, it is not possible to meet steam competition by improvement in efficiency alone, and recourse must be had to lowering the investment cost through simplification of layout, elimination of nonessentials, and improvement in design; to the extensive overdevelopment of streams with respect to minimum dependable flow and continuous capacity; to the use of additional steam units to carry load increments until such time as the load has grown sufficiently to absorb the output of the next hydroelectric step; and to realizing, utilizing, and capitalizing the advantages of hydro other than its energy-replacement value. Among these may be mentioned the capacity value or peak service of even a small amount of hydro energy, as from a variable-flow stream plant during minimum flow, when properly applied; the mechanical ruggedness and quick-starting properties of hydraulic units; diversity of maintenance work and station trouble; improved reliability and distribution economy obtained by a strategic arrangement of points of supply from the independent hydro and steam sources; stability of annual cost; and sometimes the location value of hydro plants, as, for example, a small local plant at the market end of a long transmission line the economy of which depends on the maintenance of a high line load factor.

Another former practice which is being and should be discarded is the requirement that the development of a water-power project must effect a handsome saving or profit as compared with an all-steam supply. It is encouraging to note that in the case of a recent important project the backers of the development stated at once that in dollars and cents the project might not effect any immediate saving, but pointed out that if the costs of hydro power and steam power are approximately the same, the desirability of conserving our fuel resources should throw the balance in favor of hydro power.

A noteworthy current activity is the revamping and in some cases the complete reconstruction of old hydraulic plants.

A phase of the hydraulic-power business which is receiving considerable thought is practice in drawing up contracts and purchasing equipment. As noted last year, the manufacturers have felt that, owing to competition and perhaps some slowing down of business, prices have been very low and have left little margin for experimental work. On the other hand, the users of equipment have pointed out the keen competition with steam power and the need for rock-bottom prices. A solution that has been offered is an improved form of bonus contract with less stress on high guaranteed efficiencies and a reward for efficiency in excess of the guarantee. An interesting example of such an arrangement which worked out satisfactorily to both parties is the recent replacement of the buckets on the original Big Creek impulse wheels of the Southern California Edison Company. The power company agreed to pay the manufacturer a certain amount for the new buckets and a bonus of so much per kilowatt for any increase in output obtained with the new buckets over that obtained under like conditions with the old buckets. A considerable increase in efficiency and capacity was obtained. The manufacturer immediately devoted his bonus to further experimental work, as a result of which still more efficient buckets were developed.

There is an encouraging tendency in the West to effect cooperation between irrigation districts and power companies. In several cases the utility company owns and operates the power plant built in conjunction with the irrigation dam, paying the district a stipulated charge for the released water.

There is no cause for pessimism as to the future of water-power development. Necessity is a good stimulant. The working out of the various problems mentioned, together with the undoubted popularity of water power, should insure the development of large additional amounts.

Dams

The failure of the St. Francis dam in California has received much publicity. The causes have been thoroughly investigated and are well understood, but cannot be discussed here. The failure has undoubtedly shaken the confidence of the public in the stability of existing dams, although the fault was in the foundation rather than in the dam itself. The lesson seems to be that the work of municipalities should be subjected to supervision just as much as privately owned dams. It is to be hoped that in the effort to remedy the situation and restore public confidence in the safety of dams, extreme legislation will not be passed unnecessarily increasing the size and cost of the structures.

The completion of the principal tests on the Stevenson Creek Arch Dam and the publication of data and findings in the Proceedings of the A.S.C.E., May, 1928, Part 3, under the auspices of the Engineering Foundation, are an important achievement and have done much to put the design of thin-section, and particularly arched, concrete dams on a scientific basis. As described in the test report, tests made by Professor Beggs with a celluloid model one-fortieth of actual size indicated the probability that deflections in an arch dam can be predicted accurately from tests on models. Since the printing of that report, tests have been conducted with a concrete model at Boulder, Colo., which confirm the previous important findings regarding prediction of deflections in full-sized arch dams.

As a result of research work and experience there is increasing confidence in less-than-gravity-section types of dams. Several multiple-arch dams have recently been constructed. The Coolidge dam of the U. S. Indian Service on the Gila River, Ariz., recently completed, is a unique multiple-dome type.

There is an increasing use of rock-fill dams with thin reinforced-concrete faces.

Much study has been given to the design of dam aprons to prevent erosion of the foundation at the toe. The Conowingo and Norwood dams are notable examples of apron design based on experimental research.

There is an increased tendency to install permanent and substantial crest gates on dams rather than renewable flashboards. Clear-crest dams have become the exception rather than the rule. There still remains considerable room for improvement in the design of deep-crest gates and their operating mechanism to insure simple and reliable operation and low maintenance as well as investment cost. Recent floods in several sections of the country, particularly in California, with runoffs in many cases twice as great as any previously recorded, have shown the necessity for more liberal design and substantial construction of crest gates.

In 1928 two especially large roller crest gates or rolling dams, each 115 ft. long and 18 ft. high, were put into operation at the Bellows Falls plant of the New England Power Company on the Connecticut River.

As a means of rapidly draining reservoirs in times of emergency, an alternative for additional crest gates is the installation of discharge valves. There is an increasing demand for an inexpensive valve of large capacity. Such a valve need not be efficient. It will be called upon to function perhaps only once in several years, but at such a time must be capable of discharging a maximum quantity of water in a minimum time.

A feature of masonry dams with respect to which there is considerable difference in practice is the provision of inspection galleries, particularly for lower-head dams. Standardization in this respect may not be desirable, but there appears to be room for the dissemination of information and the establishment of principles of good practice.

An important subject of current investigation is the proper proportioning of concrete and methods of mixing and pouring, especially in northern climates. Attention has been called to a number of dams recently repaired which are less than ten years old.

Important Hydraulic-Power Developments

An unusual number of hydroelectric plants which are noteworthy either for size or special features or both have been put into successful commercial operation recently. Among these may be mentioned the Conowingo development on the Susquehanna River, containing the largest turbines in physical size yet built on this continent; the Louisville development on the Ohio River, the largest semi-automatic plant in operation and containing the largest propeller-type wheels in physical size that have been installed in the United States; the Narrows development on the Yadkin River, with several unique features; the Bucks Creek plant on the Feather River, with the highest head yet developed in America (2562 ft.); the Bucks Creek 2A plant, containing impulse units of record capacity (56,000 hp.); the Lake Chelan development in the State of Washington; the Upper Tallassee development in Alabama; the Bellows Falls development on the Connecticut River; the Rocky River development in Connecticut, the first important plant in America to use in large part pumped water; the small automatic plant built on "stilts" over the Kentucky River at Dam No. 7; the Glines Canyon plant in the State of Washington, the Spaulding No. 3 plant in California, and the Alouette plant in British Columbia, all notable automatic plants; and the extension of the Great Falls plant, Manitoba, containing propeller-type wheels notable for size and high head (56 ft.). Data regarding these installations may be found in the reports of the Hydraulic Power Committee of the National Electric Light Association on "Bibliography of Hydraulic Subjects and Manufacturers Statements" for 1927 and 1928. Special features will be mentioned hereinafter.

Important projects now under construction are the Paugan development on the Gatineau River, the Alcoa development (Chute-à-Caron) on the Saguenay River, and the Back River development in Canada; Jordan Dam (Lock 18) on the Coosa River; the Saluda, Waterville, and Oxford developments in the Carolinas; the Lower Tallassee development in Alabama; and the Fifteen Mile Falls development on the Connecticut River.

Turbines and Accessories

The propeller-type turbine continues to hold a prominent place in hydro-plant equipment. The completion of the Great Falls, Manitoba, plant, with a total installation of six high-speed wheels each rated at 28,000 hp. at 56 ft., after a lengthy experience with the first units, is worthy of note.

Probably the outstanding current development in the turbine field is the adjustable-blade runner, which with manual operation, requiring the shutting down of the unit for adjustment, makes possible increased output under reduced head during flood flows, when efficiency is not a consideration. The largest units of this type in America will be the wheels rated at 8800 hp. at 26 ft. and 85.7 r.p.m. in the Back River plant in Canada, now under construction.

When the turbine-blade angle is changed automatically, high efficiency is obtained at part load, thus overcoming the principal disadvantage of the propeller-type turbine. The first installation of this type in America will be at the Devils River plant of the Central Power & Light Company in Texas, with a wheel rating of 1900 hp. at 33 ft. and 277 r.p.m. Based on laboratory model tests, the manufacturers expect the wheels to exceed 80 per cent efficiency from 575 to 2300 hp., and 90 per cent from 950 to 1575 hp.

In reviewing the year's progress, special mention must be made of advance in the design of impulse wheels, which is of particular importance in the West. Official tests of the Bucks Creek wheels showed efficiencies of 85 per cent or better over a considerable range.

The increase in cooperation between power companies and irrigation projects has emphasized the importance in such cases of obtaining high efficiencies over a wide range in head. The Melones plant of the Pacific Gas & Electric Company is a notable accomplishment in this respect.

Governors are being equipped with new control devices to adapt them for automatic or semi-automatic plant operation. The electric governor drive is being used in an increasing proportion of new installations.

Many turbines have recently been equipped with automatic air admission valves for increasing part-gate efficiencies and particularly for facilitating operation of the direct-connected generators as synchronous condensers for power-factor correction and voltage regulation.

The effort to reduce the cost of low-head turbines has led to the construction of turbine parts such as distributer rings, stay vanes, and head covers of welded plate and structural steel.

Repair of pitted turbine buckets by electric welding has become standard practice. Efforts to find a cheap substitute such as type metal, which will serve as a cheaply applied but durable filler, have as yet been unsuccessful.

Several additional rubber guide bearings have been installed on large turbine shafts, and those previously installed continue to give excellent service with negligible wear.

There is an increasing use of large butterfly valves instead of head gates in turbine intakes. The principal advantage is the tight seal which can be obtained, with consequent reduction in leakage during shutdown. The largest valves of this type, with a diameter of 27 ft., are in operation at Conowingo. These valves are sealed with rubber rings or tubes $\frac{1}{2}$ in. thick and $3\frac{1}{2}$ in. outside diameter imbedded in the casing around the valve disk and held in place by steel keepers. These seal rings have

exceeded all expectations. A test with normal head pressure on the gate and a hydraulic pressure of 80 lb. per sq. in. applied to the sealing tube showed a leakage of less than $^1/_2$ cu. ft. per sec. A test on a $12^1/_2$-ft. butterfly valve at Rochester, N. Y., on a unit operating at a head of 130 ft., showed a leakage of less than $2^1/_2$ gal. per min. Another test on a 102-in. valve under a pressure of 100 lb. per sq. in. showed a leakage of 4.1 gal. per min.

Cylinder gates outside of the wicket gates have been used in at least two recent turbine installations to reduce leakage to a minimum.

Other Features of Hydroelectric-Plant Design, Construction, and Operation

There has been a notable development and use of equipment for the semi-automatic or remote control of individual generating units within a station, as at Louisville, and for the automatic operation of a plant as a whole, particularly when it is suitably situated with reference to a larger master station. Automatic operation facilitates the development of isolated water-power sites and serves in some measure to meet the decreasing cost of steam power. Particular interest centers on plants in which there is no governing equipment. Important automatic plants which have been put into operation recently have already been mentioned.

The overlapping of the heads of plants in series on the same stream is becoming more common. Under this arrangement headwater at the lower plant is normally high enough to cause backwater in the tailrace of the upper plant.

As a means of reducing the first cost, the so-called outdoor or semi-outdoor type of station has recently been adopted in several instances. The most notable example is the Norwood plant, with a close-fitting individual removable plate-steel housing for each generator. Another interesting feature of the Norwood plant is the improvement of overall plant efficiency by the installation of two different types of Francis unit. There are two relatively high-speed units and one with lower speed and capacity but higher part-gate efficiencies for load and frequency regulation.

In recent years much study has been given by many companies to the working out and following up of schedules or rules for the most economical distribution of load among units and stations. In the last analysis all of these schemes depended on the human element in that the operator was relied upon to carry out the proper loading. Recently a method has been developed for the automatic control of the loading of generating units and plants. The device, which in effect is a mechanical operator, is at the time of writing being installed at the Norwood plant. The equipment consists of instruments for the control, through the operation of the synchronizing motor on the turbine governor, of the load on a unit, while the governor continues to care for sudden load changes in the usual manner. In effect the device does what a skilled operator would do after a governor action in "touching up" the synchronizing motors on the units affected in order to restore or maintain the proper load. The system can be applied to distribution of load between stations, hydro or steam, as well as among individual units in the same station.

Another automatic-control device which functions through the governor-synchronizing motor is a frequency control. This seems to have been worked out independently in somewhat different form in two or three places.

Last year's report pointed out that the troublesome problem of penstocks for high-head plants has apparently been solved. It is interesting to note that the three plants in America with the highest heads—Balch, Bucks Creek, and Big Creek 2A, with heads of 2381, 2562, and 2419 ft., respectively—have used band-reinforced steel pipe, consisting of a welded steel core around which are shrunk seamless steel bands. With these bands the thickness of the lap-welded core can be kept within limits which insure good welds.

A need has been felt for an improved design of intake structure and gate mechanism for the control of a flow tunnel leading from the bottom of a deep reservoir. Vibration trouble has been experienced with two different types of regulating gate at part-gate openings.

Much attention is being given to power-house-crane design, long-distance water-level gages, continuous or intermittent water measurement by the use of venturi sections, etc., the removal of trash on racks by mechanical rakes, the prevention of ice accumulation on racks and turbine parts by electric heating, electric means of keeping fish from entering intakes, and mechanical fish elevators.

Pumping Equipment

The Rocky River generating and pumping plant mentioned in last year's report has been in successful operation since the spring of 1928. As the electrical capacity of the plant will not be required by the system until next year, full use has not been made of the plant this year. The reservoir was filled to an elevation 10 ft. below the maximum for the initial project. The pumps have handled several billion cubic feet of water. This project, the first of its kind in America, is probably the forerunner of numerous generating plants using in part pumped water. The project is fully described in a paper by E. J. Amberg, published in the *Journal of the A.I.E.E.*, August, 1928.

Progress in centrifugal-pump design has been similar to that in turbine design in the application of high-specific-speed runners of propeller or semi-propeller type in the range of low or moderate heads.

Testing and Research

There has been a great increase in recent years in laboratory experimental work and field testing. Several power companies as well as all the principal manufacturers now have well-equipped laboratories. There is an increasing use of models, not only for testing turbine performance but also for determining the proper design and layout of intakes, casings, draft tubes, valves, and even of an entire project, with power house, dam, tailrace, river channel, etc., all reproduced to scale.

The practice of making a field acceptance test of large turbines or of at least one of two or more similar units is becoming general, and the operating value of actual performance data is widely recognized. From June, 1920, to September, 1928, more than 175 individual turbine tests were made in the United States and Canada by the Gibson pressure-time method. About 120 wheels have been tested in the United States and Canada by Prof. C. M. Allen, using the salt velocity method, in addition to which many tests have been made by this method by power companies on the Pacific Coast.

The importance of research work, both in the laboratory and in the field, is more generally recognized.

A monumental work which should be of particular interest to those who wish to follow hydraulic research, is the report on "Hydraulic Laboratory Practice" which is being published by The American Society of Mechanical Engineers, sponsored and edited by John R. Freeman. This work consists of a translation of "Die Wasserbaulaboratorien Europas" (The Hydraulic Laboratories of Europe), with extensions of several of the original chapters to include recent researches and experiments, several appendixes describing European and American laboratories, and three appendixes treating of the principle of similitude as applied to experiments with models of hydraulic structures. It is hoped that the book will be available about the time this report is pre-

sented. The Society and hydraulic engineers everywhere are greatly indebted to Mr. Freeman for this work.

BIBLIOGRAPHY

A complete bibliography of hydraulic literature may be found in a recent serial report of the Hydraulic Power Committee of the National Electric Light Association on "Bibliography and Manufacturers' Statements." It would be unnecessary repetition to present a bibliography with this progress report.

Other recent reports of the N.E.L.A. Committee which are of special interest to the members of this division are "Waterwheel Testing and Operating Records of Plant Discharge," March, 1928, and "Mechanical Reliability of Hydro-Electric Units," July, 1928.

ACKNOWLEDGMENT

The undersigned wishes to acknowledge his indebtedness and express his thanks to the many members of the Society and other engineers and manufacturers whose contributions and suggestions have been freely used in the compilation of this report.

RALPH L. THOMAS.

Progress in Steam-Power Engineering

Contributed by the Power Division

Executive Committee: Vern E. Alden, *Chairman*, W. F. Ryan, *Secretary*, John A. Hunter, F. M. Gibson, and V. M. Frost

DURING the past year we have seen a great deal of intensive work in the consolidation of gains incident to past progress and the raising of the average standard of steam-station design and operation throughout the country, although there have been no strikingly new developments.

The developments, which during the last 15 years have made it possible to reduce by 40 per cent the fuel consumption per kilowatt-hour in steam-electric generating stations and to effect a reduction of more than 50 per cent in fuel consumption for power generated by the mercury-vapor process, are ample evidence of the intensive work done by hundreds of designing and operating engineers. One of the most important factors which has contributed to rapid progress is the free exchange of ideas and the pooling of operating experience through the medium of the A.S.M.E. and the Prime Movers Committee of the National Electric Light Association. Steps have been taken during the last two years by the A.S.M.E. Power Division to provide for the freer exchange of ideas between those of our members who are associated with the industries. It should be a source of satisfaction to the many designing and operating engineers, who by their work have contributed to the progress in steam-power engineering, to know that they have had a substantial part in bringing about the present era of prosperity in this country, resulting in no small measure from the abundant supply of cheap power with which the efforts of each man in industry have been supplemented. It should be no less a source of satisfaction that the rapid progress has been so largely the result of full cooperation and the pooling of ideas and operating experience, for where else than in the United States could this have happened?

SOME MAJOR OBJECTIVES ATTAINED

It is interesting to take stock of some of the major objectives actually attained:

1 The types of fuel preparation and burning equipment which are available permit the efficient burning of coal varying in grade from lignite to anthracite.

2 Fuel-preparation and burning equipment is available which is sufficiently flexible so that coal of widely varying grades may be burned in connection with a single installation.

3 Fuel-burning equipment, boilers, and boiler accessories are available which permit the generation in a single boiler unit of the steam required for a 75,000-kw. turbine.

4 Single-cylinder turbines of 75,000-kw. capacity, tandem-compound turbines of 160,000-kw. capacity, and cross-compound turbines of from 200,000-kw. to 300,000-kw. capacity are available.

5 Equipment is available for operation at steam pressures up to 1400 lb. per sq. in. gage and steam temperatures up to 750 deg. fahr. (There is considerable evidence to indicate satisfactory operation at even higher temperatures.)

6 Equipment is available for the reheating of steam withdrawn from the lower stages of the turbine, using either the heat from flue gases or the latent heat from high-pressure steam.

7 There is available equipment for heating feedwater by means of the regenerative cycle, using from three to five stages of heating.

8 Furnace water-wall construction is available which eliminates to a great extent the use of refractories in the portions of the furnace walls, which are subjected to the highest temperatures.

9 Condensing equipment is available which will maintain high vacuum with low investment and operating costs.

10 Economizers and air heaters are available by means of which the losses in the flue gases are reduced to very low values; and the investment and maintenance incident to the use of this equipment are reasonable.

11 There is available commercial equipment for operation on the mercury-vapor–steam cycle, each unit in the boiler house being capable of developing up to 20,000 kw. capacity.

12 There is available combustion-control equipment which will maintain day in and day out in the boiler house, operating efficiencies closely approximating test efficiencies.

13 For the average power station it has been possible to reduce the make-up water to approximately 1 per cent, which may be easily evaporated with an inappreciable loss due to the degrading of heat. For boiler plants requiring a high percentage of make-up, equipment is available which makes it possible to maintain conditions of operation and a degree of reliability and availability of boiler units closely approximating that for boilers operating on distilled water.

14 The coal- and ash-handling equipment now available make very low labor costs obtainable.

It is possible, assuming favorable conditions, to produce power by using the straight steam cycle with 12,500 B.t.u. per kw-hr. of net send-out, and, assuming the same favorable conditions, to produce power with from 11,000 to 10,000 B.t.u. per kw-hr. of net send-out by using the mercury-vapor–steam cycle of generation.

We have available today all of the equipment and the knowledge required for the assembly of this equipment and for its operation to permit us to build highly efficient generating stations, varying in size from the superpower station of 1,000,000-kw. capacity to the industrial plant of 1000-kw. capacity.

PROBLEMS SUGGESTED FOR STUDY

It is interesting to speculate as to the possibility of future developments in research which will lead to the reduction in fuel consumption per unit of output. It will, however, be more profitable and certainly more effective in the reduction of the costs for power available to our generation, if we concentrate on a study of the best use of the knowledge and the equipment which are now available to us. That we may make further appreciable reductions in the total cost of power and steam, an intensive study of certain problems is urged. The responsibility for this study lies with the engineers who design the generating stations and boiler plants, the engineers who design the equipment, and the engineers who operate these plants. The responsibility for making major decisions rests with the executives of the operating companies, but the responsibility for proper guidance of the executives lies with the engineers. The problems suggested for study are:

Reliability. The need for steam-station equipment which will be available for operation during the largest possible percentage of the hours in the year transcends all other needs. Definite progress has been made in supplying this need. The almost universal use of the closed system of ventilation for generators has reduced the outage hours by at least one-third. The use of water-cooled walls for boiler furnaces has, by the elimination to a large extent of refractories and the reduction in the maximum rate of heat absorption by surface which "sees" the fire, reduced the outage time for boiler units by at least an equal amount. Some progress has been made in reducing the outage time for turbines, but there is still room for further improvement. It is mainly to the turbine designer and the engineer carrying on research in blade structures and metallurgy that we must look for further help in improving the reliability of the turbine.

The improvement of design details in connection with major equipment; the careful selection of auxiliary equipment; the division of the auxiliaries for each large major piece of equipment into two or more units; the careful design of piping, giving full weight to the operating man's viewpoint; and the carrying through of continuous and adequate inspections which will permit the scheduling of much of the maintenance and repair work for convenient periods when equipment is not needed for operation; these and other related work will go far toward reducing the time during which equipment is not available for service.

Investment. The fact that the fixed charges allocated to each kilowatt-hour on an average exceed the fuel costs by at least 50 per cent emphasizes the possibilities of a reduction in the total cost of power through a reduction in the investment. During the last three years the emphasis has been more largely placed on the reduction of investment, and worthwhile results have been obtained.

Reserve Capacity and the Date of Starting New Power-Station Extensions. On an average, the sum of the fixed charges and maintenance on reserve capacity constitute at least 10 per cent of the total cost of power on the station bus bars, and their combined value is equal to 25 per cent of the fuel cost. The importance of reducing the investment in reserve capacity to the lowest figure consistent with the maintenance of reliable service is self-evident.

The accurate prediction of the growth of power loads so as to defer extensions as long as possible and the advance planning of work which will make high-speed construction schedules possible will permit the reduction in fixed charges on unproductive investments.

Size of Units and Stations. No more important problem confronts the power-station engineer than the choice of size of units to be used in the turbine room and boiler house. Choice of units which are either too large or too small will increase the total cost of power on the station bus bars. The decision as to the ultimate size of a given station is one which can seldom be made with exactness at the time that the initial installation is made. This question is directly related to the geographical distribution of the load and the design of the transmission system.

Interchangeability of Equipment and Production in Development Costs. There is probably no single factor which will contribute more to the simplification of operation and maintenance, and the reduction of the fixed charges allocated to each kilowatt-hour generated, than the use, in a station, of main generating units having interchangeable parts. The argument for interchangeability of parts holds with almost equal force for other equipment in the station, and particularly for the important auxiliaries, such as boiler feed pumps, condensate pumps, and circulating pumps. In order to obtain interchangeability, it is justifiable in most cases to make the decision as to size of units on the basis of operating conditions and the system load as they will be when the station is half completed, rather than on the basis of conditions during the first year of operation.

A high degree of interchangeability of equipment in a given station and also interchangeability of equipment in different stations operated by the same company will tend toward reduced investments through reduced development and reduced manufacturing costs.

Quality of Fuel Burned. In many cases two or more kinds of fuel are available. Careful studies must be made to determine the wisdom of designing the fuel-preparation and burning equipment for burning one of these kinds of fuel or of making provision for burning several different kinds of fuel. The continuity of supply and the probable trend of costs of fuel must be considered.

Location. The choice of location for a new power station bears definitely on the cost of power delivered to the user, as it affects the cost of construction, the cost of fuel, the cost of operating labor, and the investment in the transmission system.

Simplification and Ease of Operation. Much can be done in the way of simplifying operation by uniformity of design throughout a given station and by the elimination of details which can readily be dispensed with. The designing engineer should, in making each decision, give due weight to the viewpoint of the man who must operate the station. The designing engineer should in every case transmit to the operating organization a clear-cut statement as to the provisions which he has made for various operating contingencies and not depend upon the art of mind-reading, which is not now well developed among operating engineers.

There is a crying need in connection with our newer stations for better operation. The concentration of responsibility for operation in the hands of fewer men, the vastly increased value of the avoidable losses under the control of each operating man, and the unavoidable complexity of the equipment which we must use to obtain a fuel economy of 15,000 B.t.u. per kw-hr., or lower, all justify and make imperative a high degree of intelligence in the men who operate our stations. Intelligence is not enough, however. These men should be given every opportunity to acquaint themselves with the details of construction and the operating principles which underlie each piece of equipment. One of the most important opportunities of which we are now in large measure failing to avail ourselves is that of making provision so that to a greater extent the results of the work which is being done by the N.E.L.A. Prime Movers Committee and the A.S.M.E. Power

Division shall filter down to these men who are actually operating the stations. Their help is needed if power costs are to be further reduced.

These problems are intimately interrelated. They form the basis for an intelligent attack on any power problem whether it involves the construction and operation of a 1,000,000-kw. superpower station, or a boiler house for an industrial plant. An intimate understanding of the fundamental principles of steam-station engineering and a knowledge of the work done by other engineers, for which there is no substitute, is presupposed. Clear thinking, which will enable the engineer to pick the solution called for by a particular set of conditions, and a full realization that the same type of solution and the same kind of results are not to be expected in connection with a 1000-kw. station and a 500,000-kw. station, are the necessary equipment of the engineers who are to effect further reductions in power costs.

It is questionable if any branch of engineering presents a more interesting problem, or one which is more important to our whole country, than the production of an abundant supply of reliable power at the lowest cost. The splendid results already obtained make each additional reduction in cost of power increasingly difficult. Difficulties have, however, always served as the incentive and not the obstacle to engineering work.

VERN E. ALDEN, *Chairman.*

Progress in the Printing Industries

Contributed by the Printing Industries Division

Executive Committee: Edward Pierce Hulse, *Chairman*, Harold E. Vehslage, *Secretary*, Irving F. Niles, Walter E. Wines, Charles F. Hart, and Joseph S. Pecker

THE Printing Industries Division presents a report for 1928 full of interest, showing the marked advance made in a field that, while not as familiar as some other engineering activities, has in it the same call for constant research and achievement.

The newspaper comes first to mind. Several times in the history of the press a limit of production has been claimed, only to be surpassed.

Marked examples of recent development show increased production of at least two-thirds over an average of earlier but yet comparatively modern presses. By skilful designing and resort to the best practice in construction, printing cylinders now run upward of 416 r.p.m., which means a surface speed of the web of paper of 26 ft. per sec. This gives, speaking of the octuple press producing 32-page papers, an output of 50,000 an hour. Until recently, 30,000 to 32,000 was a high output. Seeking increased speed compelled reconcentration on the requirement to obtain it. Iron has given way in great measure to steel for the main framing; some printing cylinders are practically solid-steel castings; teeth in forged-steel gearing are helically cut. Roller and ball bearings are extensively used, in one instance 647 ball bearings being distributed throughout the mechanism. Automatic lubrication has been developed to high efficiency. To overcome the tendency of printing cylinders to rebound at the margins of the paper, tight-fitting staggered roller bearings are giving excellent service, the wear being so slight as to be negligible.

A unique application of a ball bearing acting as an annular wedge places a ball cage beyond each cylinder bearing and slightly eccentric to it, holding the cylinders tightly against rebound and providing room for oil on the opposite or open side. Journal bearings are plain, the journals running on specially compounded white-metal surfaces claimed to overcome the seizing propensity of bronze.

As time saving is so essential a matter in the operation of presses and as rolls of paper are so quickly depleted, an ingenious device automatically applies the prepasted end of a new web of paper to the diminishing roll which at the same is severed, and this is done without materially checking speed.

The saving of time is everywhere studied. It is obvious where high speed is involved that intervals of stoppage are costly. Some idea of materials handling will be had when it is realized that 50,000 32-page folded papers make a pile about a thousand feet high, and that this is only a part of a metropolitan edition.

Convenience of operation has been carefully worked out as well as controls. Cylinders horizontally arranged on one level give ready accessibility from the floor; another arrangement places the cylinders in pairs one above the other to cut down length of floor space, but giving also ample room between units for operation. A tally system tabs the output in pressroom and office, stopping production automatically at a predetermined quantity to prevent overruns or underruns.

Inking mechanisms show recent developments radically different from usual practice. One method applies the ink under pressure through small orifices across the press, the quantity supplied being regulated by small valves at the side of press. Another method provides the usual fountain but having a hardened and ground roller which almost contacts with a companion roller running at press speed. In this case the flow of ink is regulated by a steel blade with screw adjustment. As the space between the rollers is a fraction of a thousandth of an inch, present-day accuracy of grinding machinery is apparent, as the film of ink transmitted must be uniform at all times at every point of adjustment across the press.

As a summary of newspaper printing an item of paper consumption will not be out of place as leading to recent advances in paper making and finishing. A recent Sunday edition of over 400,000 240-page papers of a prominent daily required 1200 rolls of paper weighing 1200 lb. each. Several presses were used. When it is considered that the papers are printed and folded and the sections are collected and dispatched to dealers and to the mails within a fixed time limit, some idea can be formed of what has been accomplished recently by engineers in the field of printing and collateral machinery in but one area of the field, and the end is not yet nor soon.

While paper making may be considered as a field somewhat apart from the printing industries, it is so closely related to it that some reference to recent progress will not seriously overlap.

That the consumption of paper is enormous will be noted from the single instance given. To meet the demand, paper mills are confronted with their problems of quantity production. A recent novel development has brought a high degree of effectiveness in the primary preparation of pulp by steam explosion—a decided change in method and an engineering feat of great import in paper making. Wood is chipped or cut into small pieces, say,

1 in. sq. by 1/4 in. thick; a charge of 200 lb. is loaded in a "gun" and subjected to 1000 lb. steam pressure for 3 to 5 sec.; the charge is released and shot against a "target;" a quick explosion follows, and the impact of the chips produces the pulp.

As there is considerable moisture in raw paper stock, a vacuum

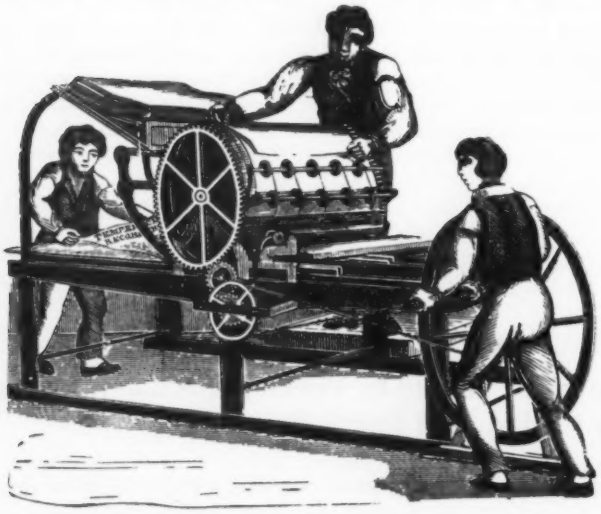

FIG. 1 FLAT-BED CYLINDER PRESS BUILT IN 1828 BY R. HOE & CO., NEW YORK, N. Y.

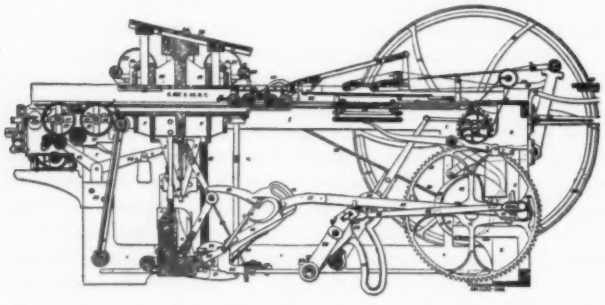

FIG. 2 BED AND PLATEN PRESS BUILT IN 1830 BY ISAAC ADAMS, BOSTON, MASS.

drier has been carried to a high degree of efficiency. It takes the stock with a moisture content of about 70 per cent and passes it into a vacuum chamber containing drying drums and out at the discharge end, the moisture being reduced to about 6 per cent. The chamber maintains a vacuum of 27 to 28 in., and the water evaporated from the paper is carried off.

While these attainments are of major importance, they are only representative of other improvement and invention constantly going on. If figures will convey a grasp of required production, the total for all grades of paper in the United States for 1928 will be close to 10,000,000 tons; of this there will be about 4,000,000 tons of newsprint grade.

An instance of meeting the persistent call for speed and increasing size is well illustrated in a recent paper-calender machine. Paper is finished on its faces, and this is done by running the web between chilled-iron rolls. As to the width involved, without going into detail as to the growth of calenders from a few feet, this latest machine carries a stack of rolls 298 in. wide on the finished face, the paper to be slit into four webs of newsprint width. The lowest roll is 36 in. in diameter; it requires 110,000 lb. of iron; the chill is 1 3/4 to 2 in. deep; the total length, including journals, is about 35 ft. The roll is cast on end, the molten metal rising from the bottom. When one considers the depth of foundry pit required, the setting of chills, pouring of metal, control of temperature—for the journals and center are soft, the surface hard and brittle—together with the condition that the hard face must be free from defects, some idea of the preparation and hazard can be formed as to what is involved in the making of these very wide machines. A stack comprises, say, eight to ten rolls arranged vertically, those on top of the lowest one being smaller in diameter. They all must be turned and ground so accurately that the blue flicker of a light will not show between the surfaces; this space is less than a quarter of a thousandth of

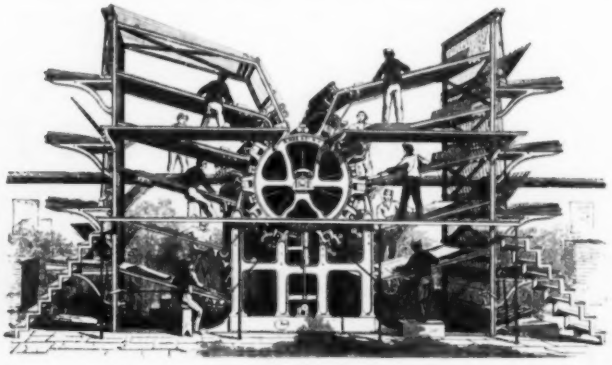

FIG. 3 HAND-FED NEWSPAPER PRESS FOR QUANTITY PRODUCTION, R. HOE & CO., 1846

FIG. 4 EARLY VERTICAL-CYLINDER NEWSPAPER PRESS BUILT BY APPLEGATH, OF LONDON, ENGLAND

an inch. The rolls are also ground for proper curvature of face to compensate for the bending effect of their weight, the lowest one being crowned ninety thousandths of an inch, the curve being that of a catenary. The calender well expresses the finesse of foundry and machine-shop practice in big machinery where every move must be carefully made.

Interesting developments in a new design of paper-cutting machine are found in a large size cutting up to 94 in. sq. It is made as fully automatic and safe as human ingenuity can devise. The knife has a double shear action, one end entering the pile slightly in advance of the other end, at the same time having a diagonal movement, this giving an easy and clean cut. The clamp for holding the paper has a flexible face of leather upon a long rubber pad, so that inequalities in the thickness of the pile

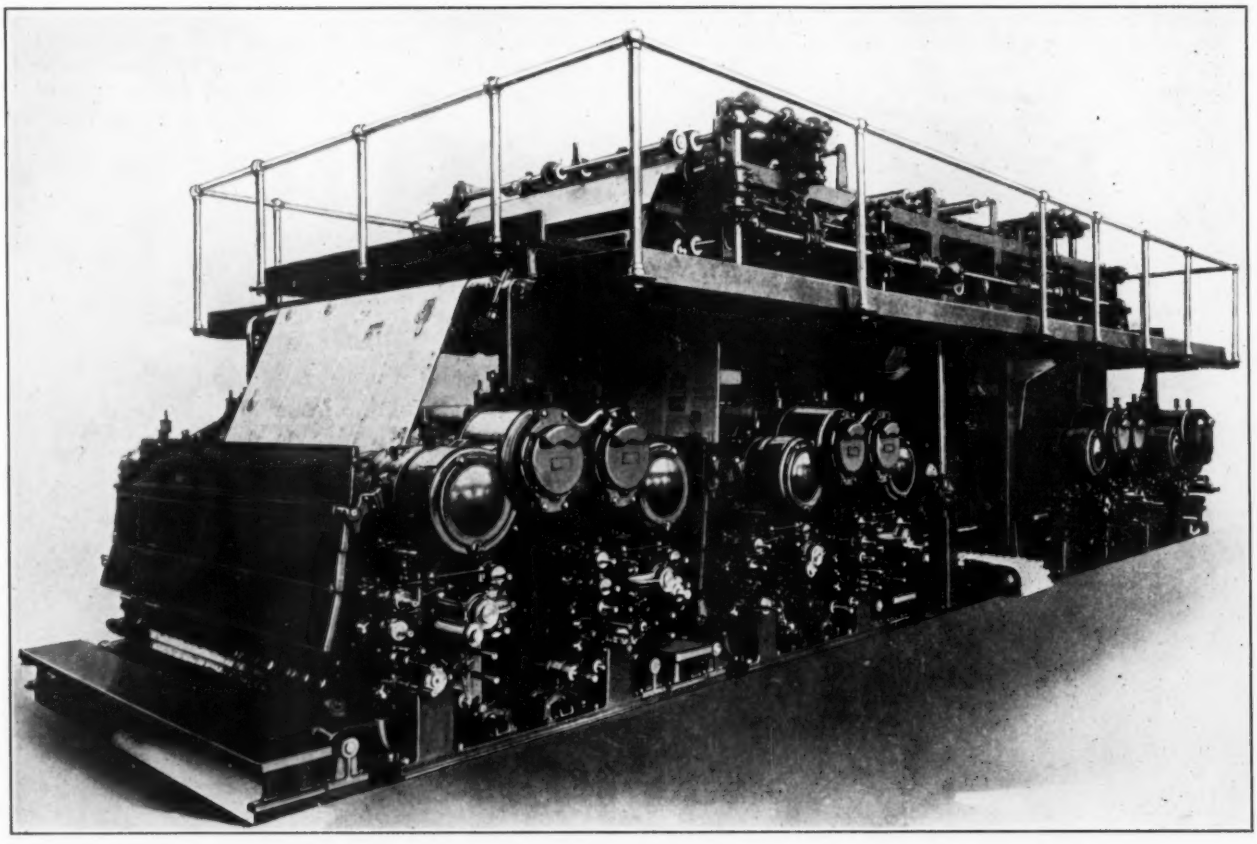

FIG. 5 MODERN CONTINUOUS-WEB PRESS, WOOD NEWSPAPER MACHINERY CORP., NEW YORK, N. Y.

are met and a firm hold is obtained, the clamping pressure being automatically applied independently of the knife action and without friction. The knife bar and clamp are of extraordinarily strong construction; a center bearing having wedge adjustment is placed between them to overcome the tendency of the knife to spring and give a concave instead of a straight cut. A safety bolt is automatically inserted in the knife bar so that it cannot repeat, and in addition a safety washer is interposed between the drive shaft and operating parts which will part and separate the knife bar from the drive in case of maladjustment or other interference with proper action.

Another attachment for safety is a two-hand throw-in lever requiring the operator to use both hands, this keeping them away from the knife while it is in operation. A solid base casting supports all operating parts, providing a foundation which is not dependent on floor conditions.

A novel adaptation of a well-known device has been carried to high efficiency in an automatic book-trimming machine. A turret having four faces is horizontally mounted so as to be intermittently turned to present each face to a trough through which piles of books or magazines up to 6 in. thick are successively fed. Each face receives its quota, which is securely clamped, turns to the right for the first or long-side trim, which is done by a knife moving down an inclined plane, cutting and returning so as to permit the turning of the turret to the third station for side trimming by two knives; thence to the fourth station, where the pile is released on a continuous conveyor. The trimmings are removed by a suction blower. Normal speed is 24 piles per minute. Three people are required: one to place the untrimmed books, one to jog them in the trough, and one to remove them from the conveyor. All else is entirely automatic. As to types of machines brought to high efficiency for mass production, the book trimmer stands out as an excellent example. There are printing plants each producing over 12,000,000 magazines a month, and as the book trimmer is the machine nearest to the fixed mailing time, it is obvious that accuracy, dependability, and dispatch are required.

As intaglio or gravure printing—familiar as the brown supplements of newspapers—has been mainly considered as requiring the continuous surface of a cylinder for etching and inking, the advent of a press using a thin copper plate drawn over part of a cylinder surface opens a large field for variety in commercial gravure work. The plates are quickly etched and attached. The inking mechanism is simple and arranged so as to overcome difficulty with the ink, which is very fluid, such as slopping at the edges. The knife for scraping ink from the non-printing surface of the plate is sensitive to adjustment, which materially reduces wear and prolongs the life of the plate. Heat has been considered necessary for quickly drying the ink, which is quite volatile. In this printing machine a blower forces air through nozzles across the sheet, which sets the ink, and the printed sheets are delivered practically dry. The cylinders are carried on roller bearings which reduce the power required and hold them firmly against the great pressure needed. The making of this machine marks the successful outcome of long experimentation to use a copper sheet in lieu of a cylinder for this class of printing.

Style and versatility in modern advertising matter has given an impetus to offset printing. This method lends itself so readily to the artist's pictorial fancy as well as to the printing of text that its field is becoming more extensive. It is indirect surface printing; a thin sheet of aluminum or zinc having a design upon it is clamped around a cylinder and prints upon a rubber blanket,

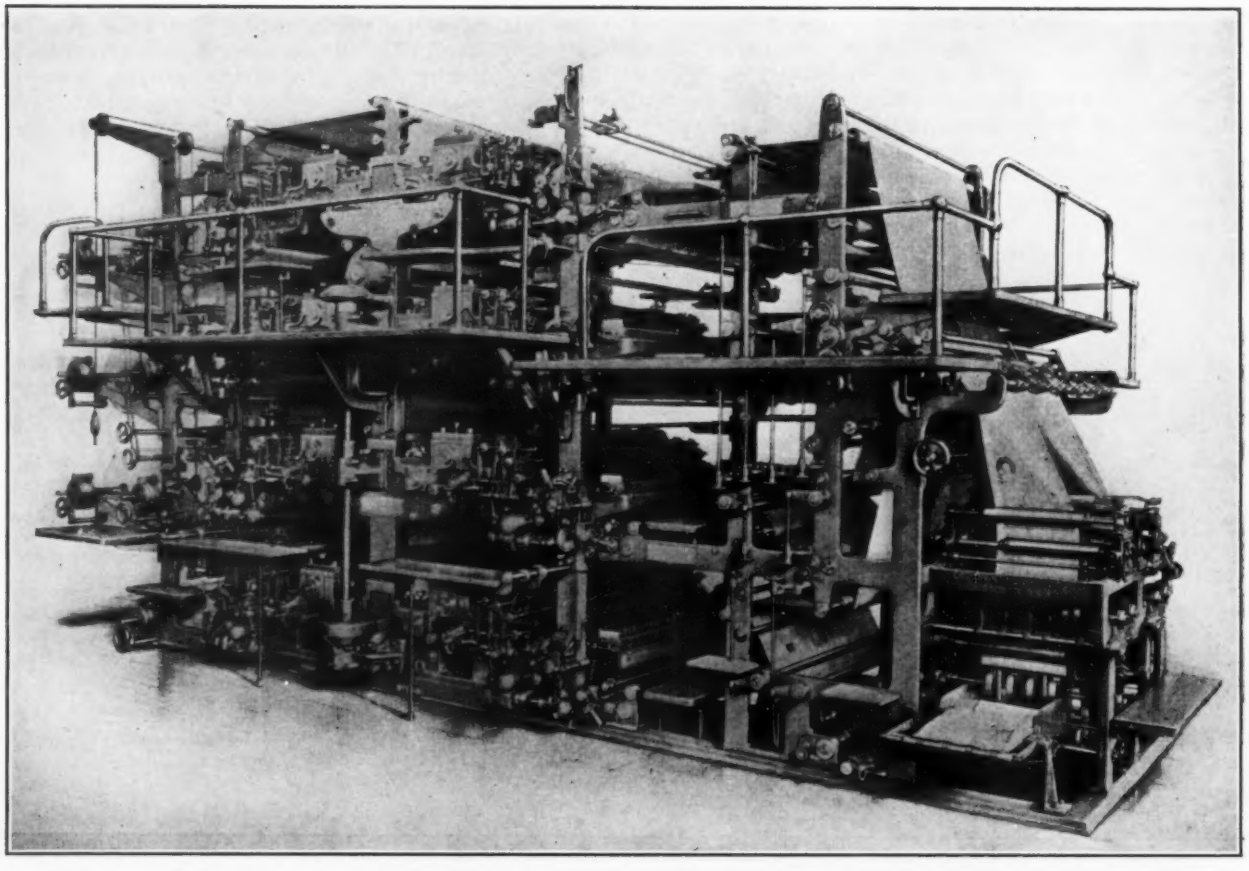

Fig. 6 Tiered Form of Press Occupying Less Floor Space, Built by Goss Printing Press Co., Chicago, Ill.

which in turn transfers or offsets to the printed sheet, which may have either a rough or smooth face, the resiliency of the blanket giving an all-over impression.

An offset press just brought out has several novel features. The cylinders are carried in frictionless bearings in solid seatings in the frames or housing. Operative mechanisms as far as possible are inside the frames, making occasional access to them secondary to facility for supervision while the press is in action.

Sheets fed from a high pile rising as it is depleted are printed and delivered to a descending platform, ready when filled to be trucked away. This makes supervision the only manual work while the press is operating, the other functions being automatic. The application of small motors to mechanisms that need not synchronize is another feature; the inking rollers are vibrated by a motor; the delivery platform is lowered and raised by another independently of the main motor, all of this tending also to smoother operation of the cylinders.

There is a parallel here to the trend to diversified drives instead of concentrating upon the prime mover, and also the growing practice of placing moving parts within framings.

As the flat-bed cylinder press was improved its speed was limited by the ability of the hand feeder. Then came the automatic feeder, which as it developed could feed sheets faster than the press could run. It became necessary to resort to the rotary principle, and rotary flat-fed presses will exceed by 50 per cent the average of standard flat-bed presses. Greater accuracy in electrotype plates as to surface and curvature has been of great help, particularly in color work where exact register is necessary.

A new two-color sheet-fed rotary press has been brought out in which sheets are fed from an automatic feeder to a first-impression cylinder, then transferred by a small cylinder to a second-impression cylinder, two colors being printed on one side of a sheet in its passage through the press, from which it is delivered to a pile delivery. Inking mechanisms are quickly moved from the plate cylinders, giving ample room for placing and removing plates. If a sheet is missed or improperly fed, the impression is automatically suspended and the press is stopped.

A press of this class finds a ready field in work such as magazine covers, mail-order catalogs, folding boxes, and color work in general.

An adaptation of the flat-bed press is had in a cutting and creasing press. The demand for cardboard containers or folding boxes has grown to such proportions that it has to a great extent superseded the use of paper wrappings. In this cutter and creaser, dies are made up of cutting and creasing rules formed to the shapes of boxes and held on the reciprocating bed of the press; the rules are lightly notched at intervals so that the cut-outs will be held together for delivery. The press cylinder makes two revolutions, one to cut and crease and the other to deliver to the pile delivery. The cylinder is equipped with a steel blanket against which the rules cut. There is no inking mechanism as the stock is printed before going to the press. After delivery the piles are stripped of waste and these boxes are ready for use. An impression trip cuts out idle running of dies against the blanket. The flat-bed principle lends itself effectively to this work and has proved very efficient and successful.

While not strictly in printing industries, a new corner-staying machine for folded boxes is closely associated. When die-cut boxes are to be formed into fixed box shape, it is necessary to stay the corners with a gummed strip. This work was slow as

formerly done by hand. In the machine the flat stock is automatically fed, formed, and corner-stripped at the rate of 100 per minute, as compared to 35 by swift hand work. This is another instance of the passing of hand labor to automatic machinery even in what may seem small operations.

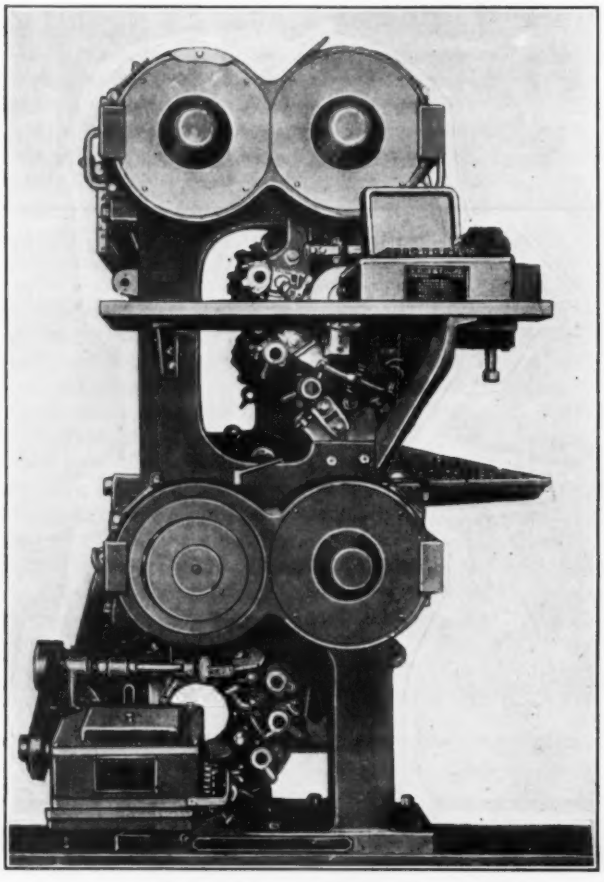

FIG. 7 CYLINDER ARRANGEMENT MIDWAY BETWEEN THOSE SHOWN IN FIGS. 5 AND 6. R. HOE & CO.

This report cannot be closed without reference to the advancement in that wonderful invention, the slug-type-composing machine. The first "Linotype" composed and cast a line of type of one size, one measure, and one face, and this was successfully accomplished only after years of soul-trying effort. In the machines of today it would seem that they almost think, so accurate are they in operation. From the early form improvement has constantly marked its progress until with the latest of the multiple magazine models eight different type faces, 720 characters in all, are immediately available on a single keyboard.

As a study in accuracy and swift completion of work assigned to it, the machine stands out as a marvel of human accomplishment. Around it have been built model factories where are found the best in manufacturing machinery and management, and also enthusiastic welfare work for the social and economic benefit of employees.

In closing, it would be well to say that limitation has compelled reference to other branches to be held open; it is, however, felt that enough has been included to show the field in its broadness.

The incentive to work in it is well expressed by H. A. W. Wood on the reception of the Cresson medal for his inventions of stereotype-plate machinery: "Of all the mechanical creations of man, perhaps that which has won him the greatest good is the art of printing. Upon it depend all other arts for their propagation and preservation. And not only do the arts, using the word in its broadest sense, pass current through the medium of the printed page and owe to it their permeability and perpetuation, but so also does every thought of the mind which is held worthy of multiplied expression."

APPENDIX

The accompanying illustrations show advancing stages in the printing industries and how manually operated machines have given way to automatic operation.

Fig. 1 shows the earliest type of an American flat-bed cylinder press, dating 1828. It was crude in build and operation, nevertheless it had fundamentals which are still used. While at first operated by man power, so much was thought of its performance that a small walking-beam engine was installed, and it became the first steam-driven press in America. The beam engine was later replaced by a horizontal one. Even in its immature form it marked the definite passing of the simple platen press into machine form.

Fig. 2 is an illustration of that oft-quoted expression "Yankee ingenuity." In the early days it was thought that the best printing could be done on a bed and platen machine, and Isaac Adams, of Boston, built in 1830 this machine, ever since known as the Adams press. The picture is in outline to give an idea of the early application of complex yet not complicated mechanisms. The bed carrying the type was raised against a platen by a toggle operated by an oscillating gooseneck-shaped cam; the inking rollers and the sheet to be printed were reciprocated by a somewhat similar cam. Other original devices paved the way for future use as improvement occurred. Its place in history is well

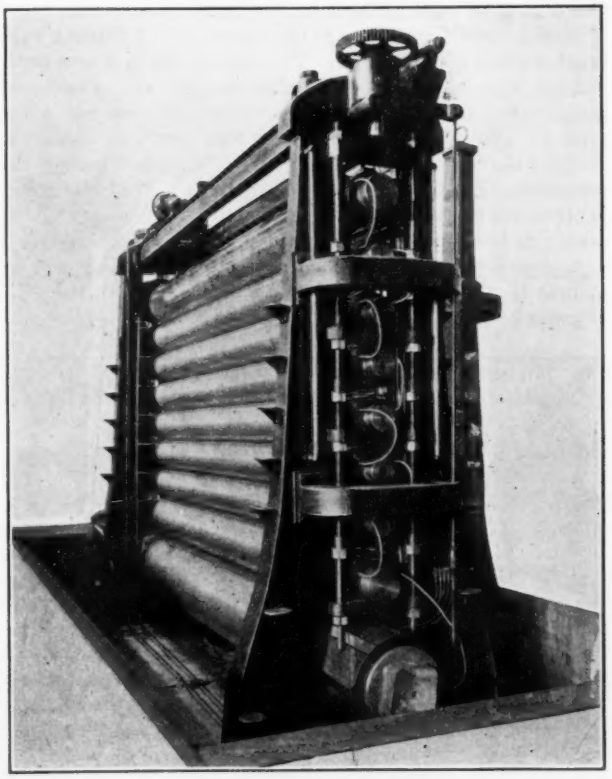

FIG. 8 PAPER-CALENDERING MACHINE, FARREL-BIRMINGHAM CO., INC., ANSONIA, CONN.

sustained by the mass of books, particularly school books, which for years were printed on it.

In America every effort was being made to meet the increasing circulation of newspapers and which could not be done by the presses then extant. Fig. 3 illustrates the culmination of the hand-fed newspaper press for quantity production.

Built in 1846, with at first four impression cylinders around a central type cylinder, it soon grew to a ten-cylinder machine with the then wonderful capacity of 20,000 sheets per hour printed on one side only. To hand-feed the paper at this rate became a highly specialized job, as missing a sheet meant an impression on the cylinder, spoiling several succeeding sheets. The expert press feeder was a very necessary character in old Newspaper Row.

About the same time experiments were going on in England, and the Applegath press (Fig. 4) was devised. It had been asserted that type could not be held on a horizontal cylinder due to centrifugal force and gravity. This press was built with vertical cylinders; the feeders were arranged around it, the sheets being carried by tapes from horizontal to vertical position and removed by hand. The large cylinder was polygonal on its surface to match each column of type. As strange as this construction seems, the London *Times* was for years printed on it, until it finally gave way to the American horizontal press in which the type was held between V-shaped column rules.

Passing from the old days to the present, Fig. 5 illustrates the progress made in the interval. The separate sheets of newspaper had long ago given way to the continuous web; and as spoken of in the report, this press is one of the latest achievements in fast presses. The illustration is used to show not only change in method, but also the general ensemble of a modern press. For comparison, Fig. 6 shows a form of press, many of which are now in operation, and in which the tier form of construction is used as occupying less floor space for a given capacity.

Another arrangement of cylinders is shown in Fig. 7, somewhat midway between the two presses just mentioned. In this style of press the cylinders are arranged vertically in pairs and

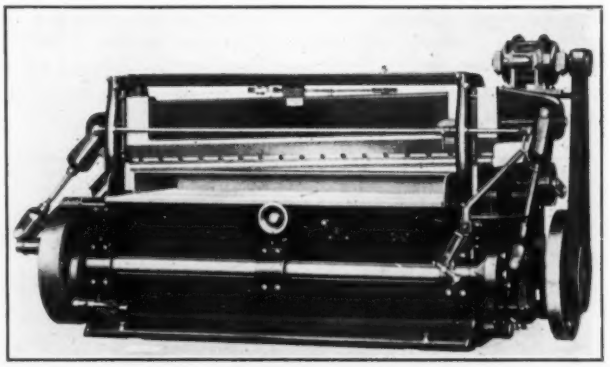

Fig. 9 Paper-Cutting Machine for Use Mainly in Paper Mills, Harris-Seybold-Potter Co., Cleveland, Ohio

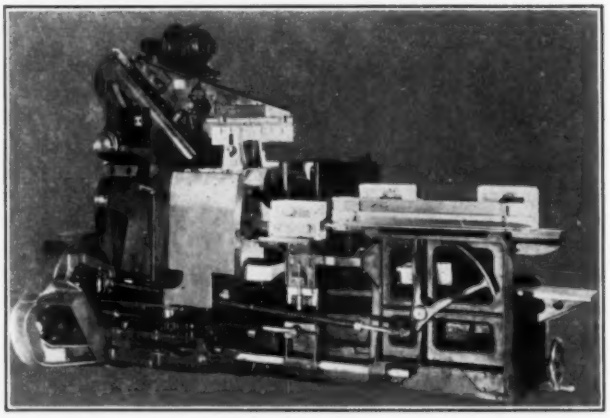

Fig. 10 Book Trimmer, Harris-Seybold-Potter Co., Cleveland, Ohio

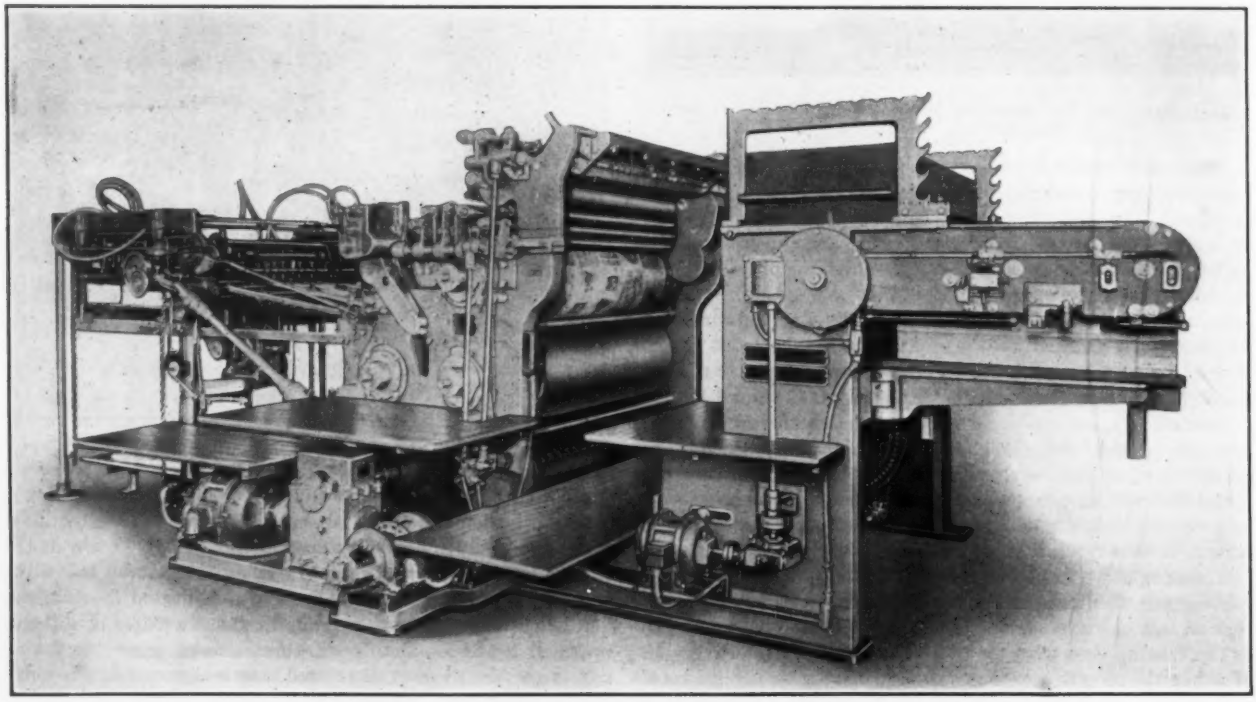

Fig. 11 Latest Type of Offset Press, R. Hoe & Co.

the facility for operation is evident; the flow of ink, for instance, being regulated by the series of small valves at his right hand. As these press units are assembled to make the complete press, ample room is given between them for operation and attention, and floor space is conserved.

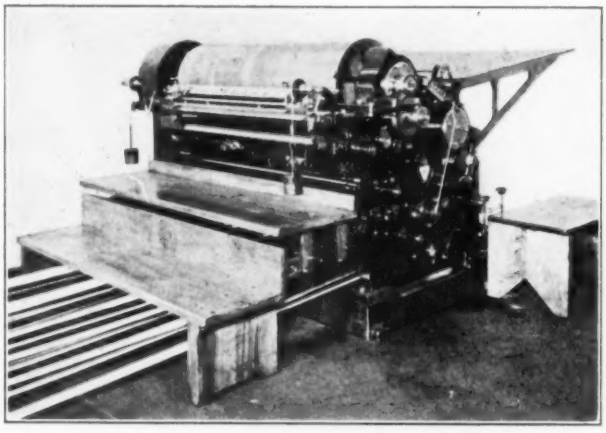

FIG. 12 PRESS FOR COMMERCIAL INTAGLIO PRINTING AND ART WORK, HARRIS-SEYBOLD-POTTER CO., CLEVELAND, OHIO

The paper-calendering machine (Fig. 8) will convey some impression as to what is needed for finishing the surface of paper. While those who know paper making will recognize a familiar part of mill equipment, others have no idea of the large proportions and accuracy of a stack of finishing rolls. As the web of paper passes between the rolls, not only is finish involved, but also uniform thickness, which must be maintained at a speed of a thousand feet a minute. This makes it apparent why great care is used in grinding the roll surfaces. One feature is the removal of rolls for regrinding in a grinding machine built for that express purpose; the housings are formed to pass the rolls at their ends. The temperature in grinding is controlled by an air blast on the roll. The illustration of a nine-roll-high stack does not show the latest 298-in.-wide machine; however, the inspector at the left will by comparison give a good idea of width, height, and massiveness.

A large paper-cutting machine of entirely new design intended mainly for paper-mill use is shown in Fig. 9. It is equipped with every means for quick action, as mill work in sheets must be trimmed speedily and cleared from the cutter. The speed of descent of the knife is very rapid, and the strain of the cut calls

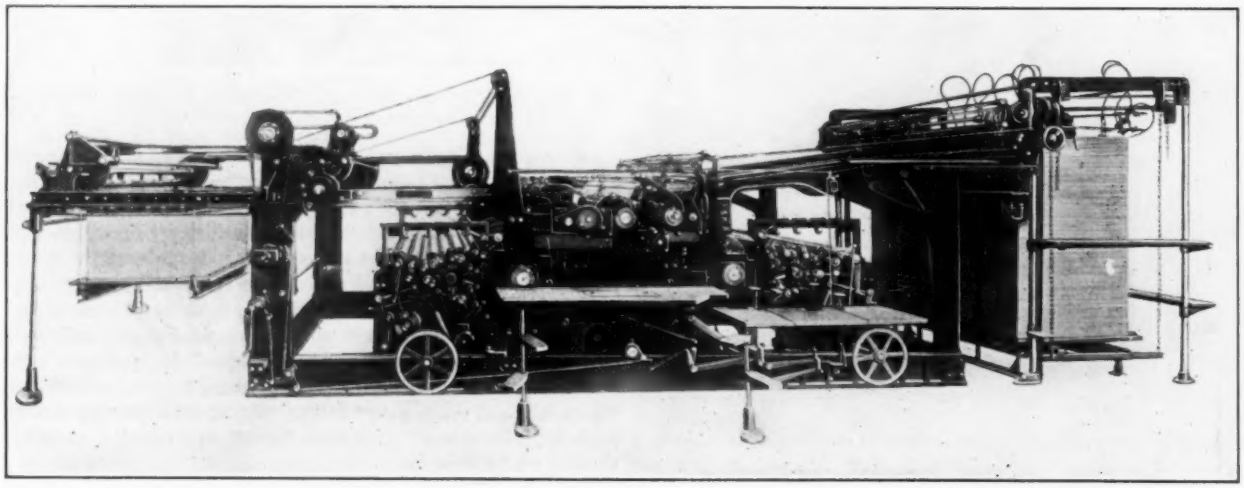

FIG. 13 ROTARY TWO-COLOR PRESS USING CURVED ELECTROTYPE PLATES, BABCOCK PRINTING PRESS CO., NEW LONDON, CONN.

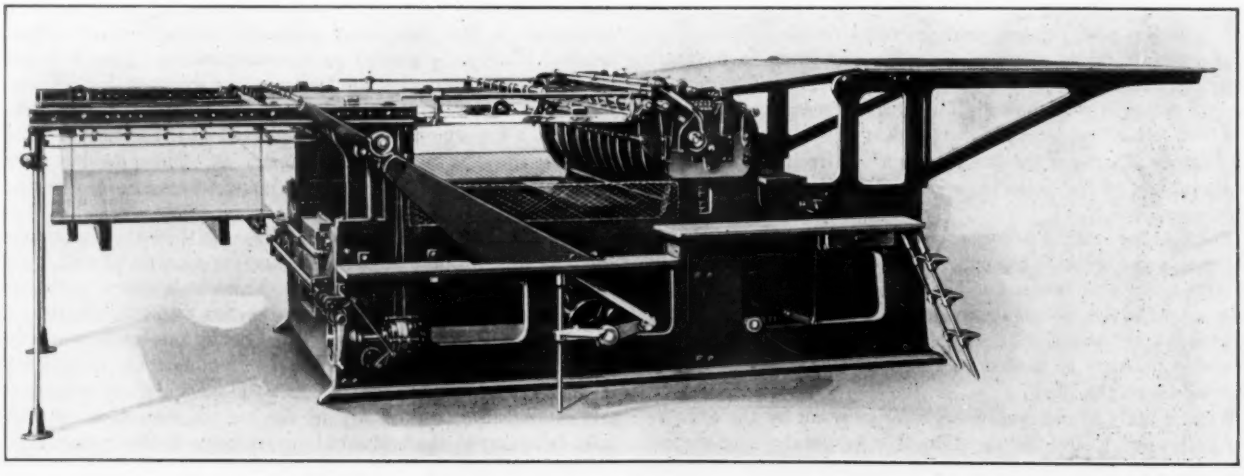

FIG. 14 CUTTER AND CREASER PRESS, BABCOCK PRINTING PRESS CO., NEW LONDON, CONN.

for a strong structure to obtain straight trimming. The machine takes up to 94 in. sq., and is an instance of the trend to handling large volume in large sizes.

The book trimmer has become a very necessary adjunct to the publishing house sending out large editions of books or magazines. The latest model is shown in Fig. 10. It is really a spectacular machine when operating. The feeding of piles of books at the right end, the advance on to a side of the turret, the clamping and turret turn for the first cut, a swift descent and return of the long knife, another turret turn for side trimming, and then another to deliver the trimmed books on the continuous conveyor, and thence away from the machine, are thought-inspiring as to what man will do next. As quantity production is requisite, the machine must be powerful, certain, and durable in action.

Fig. 11 shows the latest in offset printing presses. It is interesting to note the endeavor to keep the outside of a machine as free as possible from moving mechanism as compared with the old practice of trying to keep it in sight. In this press there is a

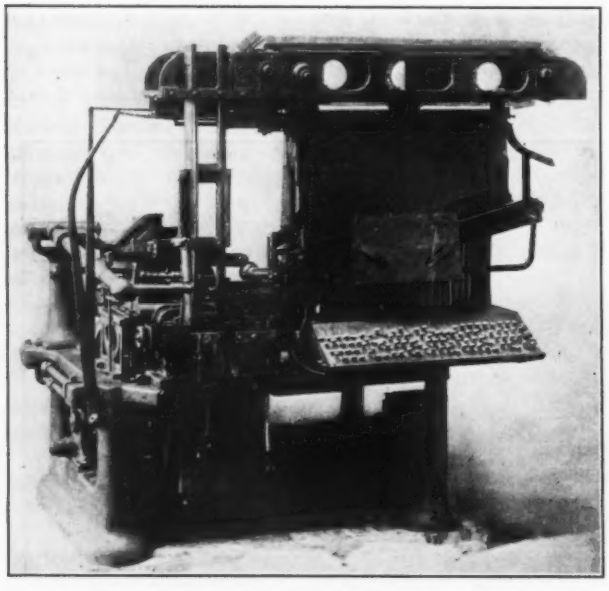

FIG. 15 THE FIRST LINOTYPE, MERGENTHALER LINOTYPE CO., BROOKLYN, N. Y.

studied effort to have the machine as clear as possible for quick manipulation. It is automatic as far as it can be; sheets are fed from the pile, printed, and delivered on the pile; and the delivery platform is mounted to swing out so as to facilitate carrying away on a lift truck. The application of motors at remote points is well shown. The great increase in advertising has been felt in the demand for this class of work. Even a cursory glance at some of the fine color work so freely found will tell of the ability of the press to produce it in attractive form at a high speed.

The field for intaglio printing for commercial and art work will broaden, and to meet it the press shown in Fig. 12 has been built to anticipate the demand. The copper sheet on the upper cylinder with the etched design and the knife for scraping off surplus ink are well shown. The press must be strong, as considerable pressure is needed to take the ink from the etched depressions on the plate.

While mainly in one tone now, color printing by the gravure process is coming, and the use of the thin copper sheet for picture and text may make this press the forerunner of more elaborate machines for multicolor work.

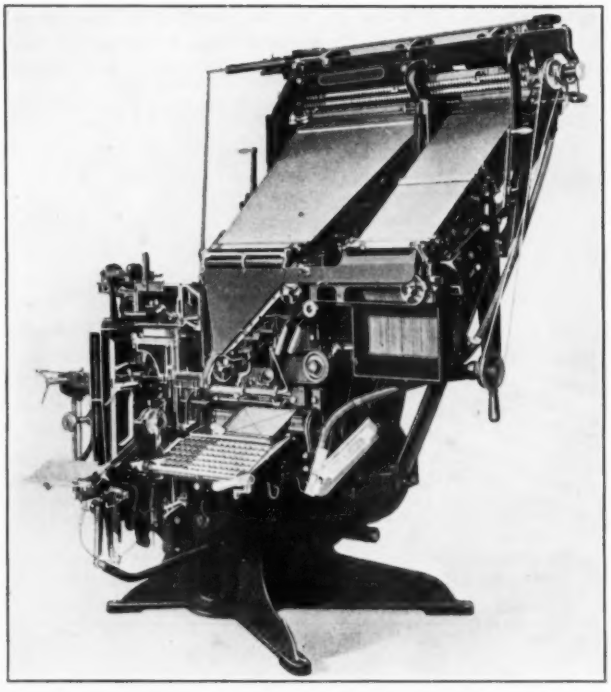

FIG. 16 THE MODERN MULTIPLE-MAGAZINE LINOTYPE, MERGENTHALER LINOTYPE CO., BROOKLYN, N. Y.

Color work will always be attractive and increasing in its call on the press. Fig. 13 shows a new rotary two-color press printing from curved electrotype plates. This press has been termed universally adjustable, because of the facility for operation and the means for getting under way quickly. It registers the colors perfectly at high speed and utilizes the automatic sheet feeder.

The cutter and creaser press (Fig. 14) is an adaptation of the flat-bed cylinder press and shows how an old principle will often lend itself to a new use. That presses of this type have been very successful is evidenced by the demand by box makers and others using cut-out shapes. For cutting and creasing heavy stock for folding boxes, it is very efficient in producing quantity without undue wear on the dies.

The first linotype slug-type-casting machine is shown in Fig. 15. This shows really the life work of Ottmar Mergenthaler, after whom the linotype company was named. It cast only a line of a single type face but did it so well that it was soon in operation in the composing room of the newspapers. The original linotype, regarded as so revolutionary in its day, has grown into the multiple-magazine machine shown in Fig. 16.

This latest development has a power-driven keyboard, a slight touch on a key sending the matrix for one of the several faces in the magazines, as selected by the operator. These machines are so nearly perfect and simple that many of them are operated without the attention of a mechanic.

The endeavor in this appendix has been to show the nature and progress in printing-industries engineering to some extent. All could not be included at this time. There is, however, sufficient to show opportunity for the engineer, for as F. S. English, a member of the Division, says: "New conditions are continually creating new problems, the need for modification in existing machinery, or the design of new. These carefully analyzed and intelligently worked out are forcing the manufacturer who intends to stay in the field into improvements in his products."

WINFIELD S. HUSON, *Chairman*,
Progress Report Committee, Printing Industries Division.

Progress in Iron and Steel

Contributed by the Iron and Steel Division

Executive Committee: G. T. Snyder, *Chairman*, F. C. Biggert, Jr., C. Snelling Robinson, W. W. Macon, and W. Trinks

CONTINUATION of production of pig iron for the remainder of the year at the average which has prevailed for the past eleven months of 1928 will bring the total for the year to about 38,000,000 gross tons, exceeding productions for 1926 and 1927, and less by about 1,400,000 tons than the corresponding figure for 1926. The steel-ingot production for the year points to a most satisfactory output by comparison, as the first eleven months of 1928 show a total production of more than 3,000,000 tons in excess of the best previous record for a similar period, made in 1926. These figures, if one has in mind the percentages of operation in the industry as reported from time to time for various districts, indicate a considerable capacity to produce these commodities above average requirements. It would seem, paradoxically, the steel plants are running full when operating at 75 to 80 per cent of capacity.

Iron Ore

An industry which creates a lake movement alone for 1927 of more than 51 million tons, a record yearly production shipped by water of 62 million tons, and an estimated tonnage for 1928 of 53 to 54 million tons, must point to considerable mechanical equipment at mines and at shipping and receiving docks. The extent of the mechanical equipment used to mine and load in cars and vessels this vast tonnage of iron ore is indicated by A. Tancig in his paper presented at the Summer Meeting of the Society. The equipment now used, as described and illustrated in Mr. Tancig's paper, makes it difficult to believe that the ore at one time was handled by picks, hand shovels, and wheelbarrows. The importance of mechanical engineering in this particular phase of the iron and steel industry is strongly brought out when one considers the use of an electric shovel with a 50-ft. dipper handle, 70-ft. boom, and 10-cu. yd. (30,000 lb.) dipper, the complete machine weighing 1,250,000 lb. and being capable of dumping 55 ft. above grade.

The importance of this branch of engineering is further emphasized in the use of large-capacity power-dump railroad cars, air-compressor plants, track shifters, crushing and screening plants, washing plants with capacities up to several thousand tons per hour, crushing and screening machinery, and the incidental maintenance and emergency upkeep equipment. The future probably points to great increases in machinery for beneficiation of much of the ore that is mined, and is a problem demanding additional serious consideration at this time.

In connection with this subject of iron ore, encouragement should be given to the presentation of a paper during 1929 devoted exclusively to ore- and coal-handling bridges. The paper might be prepared either for the Materials Handling or for the Iron and Steel Division and would be of great value, especially as it would necessarily devote a great deal of consideration to the safety features of these structures and to records of the actual functioning of the safety equipments in regular service.

Open-Hearth Furnaces

The development in open-hearth practice has not shown any radical departure in general design of furnaces or equipment. It is rather along the line of refinements, such as preheating air, insulating walls of chambers, sloping back walls, greater recovery from waste heat in gases, and, of course, continued efforts to improve quality. As one writer puts it, "future trends will be toward larger furnaces aiming at greater tonnages and lower costs, efforts to secure more refractory linings, better utilization of present sources of heat, and better control of atmospheric conditions." The mention of fuel brings up again the question of mixing blast-furnace and coke-oven gas to secure enormous volumes of a gas sufficiently rich to serve the open-hearth as well as other metallurgical furnaces.

Multiple pouring of ingots is being used to a greater extent, and advantages are claimed. The equipment for multiple pouring requires careful mechanical designing in order to be safe and effective. It is sometimes difficult to accomplish in existing plants for lack of headroom or other clearances. Tilting open-hearth furnaces are preferred in many cases and are being advocated for the well-known advantages of slag control, tapping, control of steel quality, and ability to patch bottoms. The mechanical equipment controlling the tilting of these furnaces seems to be entirely satisfactory. The insulation of checker chamber walls, already mentioned, has been the subject of a great deal of discussion, and there are many advocates. It is to be hoped that the proposed uses of insulation of these chamber walls, where applied to old furnaces, will be analyzed in all cases by careful tests prior and subsequent to the installation. The use of fans at each end of the furnaces to secure better combustion control is being tried, and satisfactory results are claimed for this innovation.

In England at the Merchant Iron Works Company at Middlesbrough-on-Tees, Benjamin Talbot of the Talbot process fame installed an auxiliary hearth to an open-hearth furnace. This device is used to preheat the metal, be it scrap or hot iron, before it is discharged into the main hearth. It is claimed that a material increase in the output of the open-hearth furnace is thereby obtained.

Bessemer

Dr. G. B. Waterhouse, of the Massachusetts Institute of Technology, has written an encouraging article in regard to making steel in bessemer converters. His tabulation of tonnages shows that the rate of diminishing percentages of steel made by the process is slowing up. The total yearly tonnages of this steel, proved so satisfactory for very many purposes, has held up very well compared with six out of the past seven years.

Many mechanical improvements are possible in a new bessemer plant, such as electric tipping, scrap charging, provision for double pouring, delayed teeming, and incidental equipment needed to reduce loss. A small amount of study and attention compared with that given the open-hearth plants might turn the tide and possibly increase the proportion of steel made in converters. That there are many uses for this kind of steel is very well known, and improvements in the practice might readily extend these uses.

Duplex Plants

While satisfactory steels are being made in duplex plants there does not seem to be much development in the way of additional plants. The large tonnages possible make this manner of making

steel attractive, although it is pointed out there are numerous difficulties to be encountered and that great care must be taken in the selection of metal fuel, the temperature control, and preliminary blowing.

SHEET MILLS AND SHEET-BAR MILLS

Continued interest is shown in the new mills which have been built during the past two or three years. Youngstown Sheet and Tube Company's 21-in. continuous sheet-bar mill at Indiana Harbor takes billets direct from the blooming mill into the new mill, ten horizontal and three edging stands rolling $6^1/_4$-to $16^3/_4$-in. skelp and the general run of sheet bar. A noticeable feature is the use of roller bearings on the off side and of bronze bushing on the drive side of the feed table. Table gears are cut and run in oil. An interesting description of this mill was given in the March 22 number of *Iron Age*. F. C. Biggert, Jr., authority on sheet mills, says in a general way: "If present indications are borne out by actual experience, we may expect to see sheet steel selling at prices sufficiently reduced to make possible its use for a multitude of new purposes. It should be noted, however, that this has not yet been accomplished. The new mills represent large investments and require large tonnages and large individual orders to make their operation profitable."

From an operating standpoint they are still in an experimental stage, and it is doubtful if any of them has yet shown costs lower than can be made by established methods. The following pertinent statement was made by an unnamed writer: "Another phase of interest in this portion of the steel industry is that most of the inventions and discoveries necessary for the successful operation of the new method have been covered by patents, possibly to a greater extent than any single industry save perhaps that of wire. The rolling process and machinery and the subsequent processing, annealing, pickling, etc., all come within the scope of this protection. It would be unfortunate indeed if the situation were handled in any but the broadest, fairest manner, for which the leaders of the American steel industry are eminently fitted."

Of passing interest is the rolling in one of the American Sheet and Tin Plate plants of 48-gage tin plate which "can be torn easily between thumb and forefinger." The field for the use of this very thin material is said to be limited, but its availability may develop additional uses.

The importance of progress in the art of rolling sheets is shown by the progressive development made by Weirton Steel Company in the three periods, 1916–1920, 1920–1925, and 1925–1927, in which horsepowers progressed 4900 hp., 6300 hp., and 8500 hp., respectively, and monthly tonnages, also respectively, 8365 tons, 11,386 tons, and 13,658 tons, rolling 18-gage 5 to $6^1/_2$ in. to 11-gage 5 to 22 in. For this information we are indebted to Mr. Badlam, consulting engineer, Pittsburgh (*The Blast Furnace and Steel Plant*, February, 1928).

At the American Rolling Mill Company's plant at Ashland, Ky., a tandem-type mill for sheet rolling has been installed. The most significant feature of interest is that the roughed sheet is preheated in a 140-ft. continuous furnace before going into the first stand of the finishing mills, and short furnaces for reheating the sheet are provided between second and third, third and fourth, and fourth and fifth stands.

COKE PLANTS

The dry quenching of coke has not, we believe, made much headway in this country during 1928. The claim of a saving of 5 per cent or over 2,000,000 tons of coke per year should encourage further investigation and, if established, promote this project of cooling by continuous passage of inert gases through the coke and reclaiming the heat so absorbed by producing steam.

ROLLING MILLS

Additional items of interest in regard to the new mills at the Homestead Steel Works of the Carnegie Steel Company are available. It has been pointed out that the construction of these large and modern mills on sites occupied by old mills that continued to operate called for what may be termed "emergency engineering" and for great resourcefulness upon the part of all who had anything to do with this great project.

There is a dual set of mills running parallel with an electric motor room between and soaking pits at the end arranged so that ingots can, when required, be fed to either mill. The buildings covering these mills are said to weigh nearly 27,000 tons and cover more than a million square feet. The weight per square foot of floor space covered seems to figure out over 47 lb., which denotes very substantial construction for buildings of this type. There is one group of mills composed of 44-in. blooming mill, 36-in. roughing mill, and 28 in./32 in. structural mill for standard sections. On the other side of the motor building are the huge 54-in. blooming mill and three 52-in. mills, roughing, intermediate, and finishing, for rolling the H-sections in depths from 8 to 30 in., direct from ingots.

While this group of mills was designed for 26,000 tons per month, it is expected this will be greatly exceeded, which is not surprising since designed tonnages in all kinds of rolling mills seem always to be exceeded, and sometimes soon after they are placed in operation. Flange widths vary from 6 to 15 in. and weights from 21 to 425 lb. per ft. The motors driving these mills range in horsepower from the 8000 hp. motor (peak rating 14,400 hp.) driving the blooming mill to the smaller motor driving screwdowns, manipulators, tables, etc., there being two 7000-hp. motors driving the roughing and intermediate set of rolls. Outstanding features are the various electric controls, and an innovation is the dual interlocked control from the ground and the crane cage of soaking-pit covers and the control of the ingot buggy by the crane operator. The distance from the center line of the 54-in. blooming mill to the hot saws is 907 ft. 6 in. One hot bed is 100 by 250 ft. Special crane equipment is provided to stock and handle the product. This entire construction program, designing, fabricating, and then erecting in the midst of old mills continuing in operation, reflects great credit on the organization effecting it.

SEAMLESS AND WELDED TUBE MILLS

Development of this branch of the iron and steel industry has been rapid, and competition is keen. Whether to build pilger mills or some other kind seems still to be a question, and advocates of both types of mills can undoubtedly point to finished production that satisfies their customers. The combination of piercing and expanding mills followed by the usual equipment points to still larger diameters than are now being made. The enticing features of pilger mills, while calling for some elaboration in the open-hearth plants, will continue to attract attention and probably promote more mills of this type.

By-passing soaking pits, a blooming mill, and a bar mill for rolling rounds is an attractive idea that will continue to be alluring. Mr. Stiefel, however, who should be an authority in the whole field of seamless-tube making, says in his paper: (1) Output in tons with plug mill is two or three times greater; (2) cost of installation about the same; (3) tool cost for pilger mills two or three times greater; (4) rolls and mandrels for the pilger mills call for special steels; (5) maintenance and tool equipment less costly for plug mills; (6) plug-mill product is of better quality; (7) pilger mills can roll longer lengths; and finally, (8) plug mills will probably be built that can produce tubes 24-in. in diameter. The controversy, if there is one, must resolve itself into the question of cost to produce from start to finish,

since the product, whether pilger or plug mill, is being sold.

An important addition to the seamless-tube industry is the new mill at Ambridge built by the Standard Seamless Tube Company. What is claimed as one of the largest piercing mills so far built is the 51-in. mill at this plant. Designed by the Mesta Machine Company in collaboration with the owners and built by the former, the equipment is of massive construction, and the piercing mill may be, as hinted in the description given in the trade papers early this year, the largest of its kind anywhere. The range of tubes to be made runs up to 15-in. outside diameter.

The piercing mill is driven by a 5000-hp., synchronous, 240-r.p.m. motor with peak power of 12,500 hp., through helical reduction gears that revolve the rolls at approximately 60 r.p.m., or about 800 ft. at the surface. The gear-drive unit stands 17 ft. high and weighs 500,000 lb. The driving spindles with universal couplings are approximately 20 ft. long. The design of guides for the mill is notable, affording quick changing. The thrust-block bearing has a rated capacity of nearly 600,000 lb., weighs 16,000 lb., and has a travel of 38 ft. Another feature that would be more notable if not now quite common practice in designing modern mill machinery is the careful attention given to lubrication throughout the mill, using forced-feed oil or grease under pressure.

Another seamless mill placed in operation by a leading interest this year has a range from 6 in. to 13$^3/_8$ in. and makes tubes up to 47 ft. long on hot bed. Rounds charged in three furnaces are 5$^1/_4$ to 9$^3/_4$ in. outside diameter and up to 16 ft. long. There is a piercing mill and expanding mill, each driven by 3000-hp., 300 per cent overload, synchronous motor. The piece is reheated after being expanded, then rolled, reeled, and sized. With about the equivalent of three months' operation, this mill has finished and shipped a tonnage about 50 per cent greater than that for which it was normally designed.

A. M. Byers Company, which controls the Aston process for manufacturing wrought iron without a conventional hand puddling, has made an arrangement with the Standard Seamless Tube Company under which the former is supplied wrought-iron billets and the latter converts them into seamless tubing by processes similar to those used in the manufacture of seamless-steel tubing. The Standard Seamless Tube Company was previously allied with Spang, Chalfant & Co., a large manufacturer of welded-steel pipe, which has generally been understood as indicating the possibility of seamless pipe capturing at least in part the welded-pipe market.

Bethlehem Steel Company has completed its very large welded-pipe mill.

Blast Furnaces

The large furnace up to about 25 ft. diameter hearth is considered good practice, and satisfactory operation of these stacks, as large or nearly as large as this, at about 850 to 900 tons of iron per day (average), is not unusual. No important improvements to stack, skip, or stoves have been noted, the changes, if any, being in details. A very considerable attention has been given by blast-furnace operators and designers to the matter of gas cleaning. This matter and the ever-present problem of flue-dust production and disposition are sufficient to occupy the minds of furnace operators between casts and deserve a great deal of thought and study. While of low heat value, the blast furnace gas is available in such enormous quantities (especially when stove equipment is efficient) that it continues to attract the attention of both engineers and operators, and it is so closely related to the dust problem that it is not to be wondered at that so many ways and means for cleaning the gas have been and are continually being proposed.

Difficulties and annoyances in the use of gas not thoroughly cleaned and the production of dust at from a few pounds per ton of iron made, to at times as much as 800 lb. per ton, justify concentration on these two matters. Huge piles of flue dust, containing as much iron as many of the ores, call attention to the loss occurring from this seemingly necessary evil in operating blast furnaces. Some recovery is made by sintering, but the practice is by no means general. Large tonnages of dust are being wasted beyond chance of recovery. Several years ago a well-known blast furnace operator urged that the most important factor in future furnace operation should be and would be along the lines of selected burden. Proper sizing and quality of coke, stone, and ores was urged.

Blast furnace practice must improve, according to various authorities, through the use of better burdens, large furnaces to secure low costs, better gas cleaning to secure good results at consuming units, and the recovery of the iron content now lost in wasted flue dust. Improvements in equipment for the recovery of the iron content in blast-furnace flue dust, either by sintering or by some other method, point to the possibility of large blast-furnace operators facing a penalty, in addition to the yield loss, for all dust wasted beyond the amount known to be recoverable.

Miscellaneous

Attention was called early in the year to the German achievement of operating a blast furnace at 1000 tons per day, largely through selected burdens. They have used sintered fines from the ores, a practice which may show results in this country far beyond present conjecture. Quoting from an article printed in February this year: "Large American furnaces, if supplied with rich sintered ores, would produce far more than anything yet achieved here or abroad." The same writer, speaking of boiler-house equipment in steel plants, mentions present efficiencies of 60 per cent, which does not reflect credit on operators. The possibility of steam plants of 70 per cent efficiency and 150 per cent rating, fired with blast-furnace gas, was mentioned. Experiences already obtained set the goal at at least 80 per cent efficiency and 200 per cent of rating.

Recovery from blast-furnace slags in the shape of concrete materials, etc., is largely a question of educating communities in their use, since plants are operating which make a very satisfactory return on the investment. As to the utility of the crushed and screened slag for concrete, an instance occurred where a contractor for a concrete coaling station objected to the use of slag aggregates specified by the customer, but later found on investigation that the results would provide a stronger concrete than any other aggregate available for the structure.

"Sponge Iron as a Melting Base" was the subject of N. K. G. Tholand's contribution in May to *Iron Age*. The production of Swedish sponge iron started about 20 years ago. As shipped to this country for steel making, it is in the form of 2 to 2$^1/_2$ in. thick disks, 10 to 11 in. in diameter, very light and porous, with a specific gravity of 2, of bluish tinge, and the iron content is as large as 97 per cent. The unwelcome impurities in this material are said to be low, since phosphorus is reported as maximum 0.013 per cent and sulphur as CaS as maximum 0.025 per cent. Claim is made that the resultant steels produced in electric furnaces show marked superiority. Increase in certain wire product from 200,000 lb. ultimate to 255,000 lb. ultimate is claimed, where no change was made in practice except the substitution of sponge iron for a portion of the former charge. This subject calls attention to the fact no news has yet come out in regard to the leading interest's extensive research work along somewhat similar lines so far as the raw material (sponge iron) is concerned.

The subject of the use of powdered coal in metallurgical

furnaces continues to be of interest to mechanical engineers for the reason that the mechanical equipment requires careful selection and design. The Eastern Steel Company, at its Pottsville, Pa., plant, in 50-ton and 80-ton basic open-hearth furnaces reports 500 to 600 lb. of coal per ton of steel ingots and 200 heats to one roof. These figures are of course not record ones by any means, but apply to furnaces fired with powdered coal. Bin capacity is provided above each end of the furnace. The preparation plant is at one end of the open-hearth plant. The aim is to deliver the coal to the furnaces to pass 80 per cent through 200 mesh. Coal desired for the purpose has an average analysis: Volatile, 36 per cent; fixed carbon, 52 per cent; moisture, under 1.25 per cent; ash, 6 to 8 per cent; sulphur, under 1.25 per cent.

While there have been some explosions, one only was serious, and thirteen years' experience does not point to extra-hazardous conditions. Development of anti-friction bearings for mill use continues on a large scale. No doubt many mill engineers have been prejudiced against this refinement in mill machinery, but experience in the use of these bearings in places where it was considered they could not possibly stand up under rough and heavy service has overcome these prejudices, so that it is no longer a question of service but of comparative installation and maintenance costs.

G. T. SNYDER, *Chairman.*

Progress in Textiles

Contributed by the Textile Division

Executive Committee: James W. Cox, Jr., *Chairman*, E. H. Marble, *Vice-Chairman*, W. L. Conrad, *Secretary*, McRea Parker, E. R. Stall, and H. M. Burke

IT IS a great pleasure to report that the textile industry has made remarkable progress during 1928, in spite of its general depressed condition. This has not been reflected to any widespread extent in actual profits as yet, but the tide is beginning to turn and prosperity is in sight for all well-managed textile concerns.

A report on the progress made during the year cannot be confined solely to technical progress, as other changes, although somewhat intangible and indefinite at the moment, are more important than the purely technical advancement.

Undoubtedly the most radical and best advance in our industry during the year is the changed mental attitude of many textile men as to the industry in general, and their own businesses in particular, in realizing that the old methods of financing, selling, and manufacturing which built up the industry in years past are not infallible, are not adequate for today, and that there may be better ways of running a textile business at the present time.

The changed mental change augurs well for the future, as a turn from a satisfied state of mind to a reasonably unsatisfied state has always been a beneficial stimulant to any industry and will be to ours.

This attitude is of course not as yet by any means general, but there has been a very noticeable change, due perhaps to a great extent to strenuous competition and small profits, if any. The present mental state will permit the proper type of mergers to be consummated, but not the old-time consolidations which, because of their fundamental structure, management, or both, invariably failed. Many keen men believe such mergers will be the salvation of the industry. Only time will tell. The old individualism, however, is rapidly being eliminated.

There have been some decided advances in management and the technical end of processing, machinery, equipment, apparatus, etc., as well as great improvement in styling and designing, but they cannot be considered so fundamentally vital as the change in mental attitude.

Generally considering all the major branches of the industry, it would seem that the most important advances during the year are:

1 Definite increases in output per machine and a tendency to increase output per employee.

2 The discovery that mass production in itself is not a money maker today.

3 A slow but sure realization that high machinery speeds do not necessarily or usually mean high production or low cost per unit.

4 A general recognition that the supply of textiles still exceeds the demand (hard for many mill men to acknowledge), and that the almost continual buyer's market existing today probably will continue for some time.

5 Products must be developed and made that fill the buyer's desire or need, with particular stress on color, decoration, and finish, real wear being a minor factor.

6 Hand-to-mouth buying evidently has come to stay.

7 More accurate and more uniform cost systems are necessary.

8 The conviction that elimination of waste and reduction of seconds are decided money makers.

9 That older methods of management are no longer profitably workable, should be disregarded as obsolete, and should be replaced by principles of management based on facts rather than on tradition or theory, and that only those concerns willing to accept these facts and base their management accordingly can hope to survive.

10 Out-of-date men, methods, and machines are fast being eliminated.

11 More technically trained men are needed in both mills and selling houses.

12 The great interest in research being manifested by a few progressive concerns.

13 Disregard to a small extent of the traditional interpretation of standardization as something fixed and permanent, not only in regard to products, but to machines, equipment, and methods of processing.

From a broad, general standpoint covering all branches of the industry, rayon has undoubtedly made the most radical advances, followed by cotton-goods manufacturing. Rayon has the distinction of being used more extensively than ever before in practically all lines in the trade, even being employed for industrial use. Outside of the two divisions mentioned, it is practically impossible to state with any degree of exactness what other branch has progressed the most.

The progress made in the major branches of the industry follows.

RAYON

There has been a more widespread use of rayon in the textile-

industry during the past year than ever before. This has been due to the much-improved yarns produced by the rayon manufacturers, better methods of handling in textile mills, and somewhat to improved machinery and equipment.

Rayon yarns have not only improved as to general properties and quality, but are now made in finer sizes and finer filaments, as well as not being bleached so heavily as formerly, all of which constitute a decided benefit.

The improvement has been in all kinds of rayon yarns: that is, with standard denier rayons, special denier rayons, and spun rayons made for either waste or cut filaments (occasionally termed "staple fiber"). The progress of rayon in the industry has therefore been so remarkable that this year more pounds of it will be used than of silk.

The intelligent use of both denier and spun rayon has helped almost all branches of the industry, but the unintelligent use or the employment of poor grades, particularly in the manufacture of low-grade fabrics, has been a detriment and generally a financial loss whenever used in this manner. There has been considerable progress in the development of all-rayon fabrics.

The most important uses of rayon in mixture fabrics are described under various other headings in this report. Noticeable progress has been made in more even denier of yarn, more regular chemical composition, better grading, better put-up, proper conditioning, improved oiling, better winding and warping, more care in finishing, development of the rayon voile as a commercial product, development of rayon velvet, refinements in machinery, particularly warping and weaving, and better-controlled humidification.

COTTON

There is no one particular outstanding advance in cotton-goods manufacturing. Perhaps the greatest improvements have been in methods of management, methods of processing, and more definitely controlled processing. There has been, however, a considerable amount of general progress in spinning, weaving, and finishing.

There have been a considerable number of failures, liquidations, and some curtailment of running time. These, with the New Bedford strike, have been serious propositions for individual firms, but generally speaking the trade is in a better condition because of them.

Noticeable progress has been made, such as: Multiple-machine operation, sometimes termed the stretching-out process. While this idea had been used (and abused) previously to some extent, it is only during the last year that its real value has been recognized by both employer and employee. Naturally, it applies more to the production of staples than of fancies, but where adaptable, every mill will be forced to use it or else forego a large part of possible profits. More careful selection of cotton. More thorough mixing. Oiling of stock before picking. Better methods of picking, particularly the use of the so-called one-process picking. Better and more humidification, especially the realization that for best results the humidity and temperature must not necessarily be the same in each process. General refinements in machinery, particularly in the use of better-machined parts, anti-friction bearings and chain drives. Considerable improvement in auxiliary equipment. Better chemical control. More universal use of temperature and pressure controls.

WOOLEN AND WORSTED

Broadly speaking, there has been comparatively little progress in the woolen and worsted branches of the trade, and the tendency still is to stick to the old ways of manufacturing and selling.

A few concerns, however, have made decided progress, principally by the employment of denier rayon, spun rayon, and rayon waste in both woolens and worsteds. There has been some slight use of cotton machinery, which has been altered to suit the work. The advantages of proper humidification have been realized by a relatively small number of mills to their great benefit.

Outside of what has been noted, considerable progress has been made as follows: Decline in the necessity for very thorough carbonizing, and elimination of some carbonizing because of better methods of scouring, picking, and carding. More common use of full-automatic looms. Refinements in machinery, particularly in the use of better-machined parts, anti-friction bearings, and chain drives. Better chemical control. Better temperature and pressure control. Tendency to humidify card and spinning rooms particularly. Tendency to eliminate the sponger before cutting up, by mills selling fabrics pre-shrunk.

SILK

Broadly speaking, there has been little improvement in silk manufacture as to management, methods of processing, or quality of product made. There has been a great improvement in designing and styling fabrics by a few firms. There has been considerable use of rayon as part of a mixture fabric, narrow-fabric plants being particularly eager to use rayon.

Silk looms have been improved through more careful design, use of better-machined parts, and anti-friction bearings. There has been a slight tendency to humidify silk mills more adequately. Some progress seems to be made in weeding out the small manufacturers operating upon hopes, a few looms, and a factor's capital, or practically none, and upsetting trade conditions, prices, and morale.

PILE FABRICS

Plushes. In so far as real progress is concerned, there has been practically none in machinery, equipment, and methods of processing. If it were not for the closed automobile, most of the manufacturers of plushes would be shut down or running a day or two a week. Rayon has been used to a small extent for upholstery plushes, being a great advantage to certain manufacturers. There have been a few cases where new and better management has save concerns from failure.

Velvets. The velvet branch of the trade is another instance where the use of rayon has saved it from complete oblivion. The development of the regular rayon velvet and the so-called "transparent velvet" has saved velvet mills from being shut down completely, and a few mills are doing a good business on these cloths. Some which did not follow are practically shut down.

Carpets and Rugs. This branch of the trade has gone along in the same old way with practically no progress or radical advances. The use of denier and spun rayon for pile yarns, all or in part, has been about the only change of note.

JUTE

Jute seems to be slipping as an American industry. Weaving jute cloths (except bagging) is practically extinct. If low-grade cotton keeps down in price and jute the same (or higher), it will be very difficult to profitably manufacture in the United States anything but the cheapest of bagging and certain twines for quick delivery.

ASBESTOS

There is a slow but sure development in asbestos. The products are such coarse, crude materials as a rule that the average manufacturer has not attempted to improve them much, and the methods of manufacture are about the same as in years past.

FELT

Woven. Considerable progress has been made in woven-felt

manufacturing, particularly in the selection and blending of wools used, as well as care in manufacturing, particularly in finishing. More products are being manufactured that really fit the purpose intended than ever before, these products being used mostly for industrial purposes. This is a decided advance and offers an opportunity for the keen woolen manufacturer to widen his field.

Pressed. Few advances have been made in this branch, as a majority of the products are generally low-grade felts used for shoes, slippers, etc. Mills are generally in the same old rut in both styling and manufacturing. There has been some little progress, however, particularly in the control of weights, dyeing, and finishing.

KNIT GOODS

The knit-goods branch of the industry has made no radical individual advances, but there has been a decided general improvement due primarily to the better rayon obtainable and refinements in machinery and equipment.

Progress has been made in: Better methods of lubricating denier rayon. Use of finer-gage machines. Simpler methods of finishing. Increase in the use of full-fashioned-hosiery machinery. Increase in amount of all-rayon hosiery. Use of spun rayon in various kinds of knit goods, especially hosiery. More and better humidification in some few mills. Tendency to standardize sizes when possible.

CONCLUSION

The textile industry in Great Britain and Europe, particularly in the latter, is making great efforts to secure basic facts and information by chemical, physical, and mechanical research, far more so on the average than we are doing in this country. This is of course a decided forward step, and will be of great assistance in broadening their markets. On the other hand, it will be many years before the European mills or those in Great Britain will be using the remarkably improved methods of management and definite control of processing that have been so successful in a small number of progressive mills in this country.

Strenuous competition with little or no profits will force us to make more rapid progress in machinery and equipment, as well as in management and methods of processing, as already mentioned.

The keen American manufacturer, with the aid of research and better management and processing methods, does not therefore have to fear European competition. American ingenuity and progressiveness, plus some kind of a tariff, will surely more than offset any condition brought about from the competition of foreign goods.

This report is a compilation of the findings and experiences of many men in the industry. It is realized, however, that no matter how broad the scope of the Executive Committee of the Textile Division, it cannot know of every development in the industry. Any information on definite progress not included in this report would therefore be welcomed by the Executive Committee of the Division.

JAMES W. COX, JR., *Chairman.*

Progress in the Wood Industries

Contributed by the Wood Industries Division

Executive Committee: William Braid White, *Chairman*, Chester L. Babcock, *Secretary*, Paul H. Bilhuber, *Assistant Secretary*, James S. Mathewson, Thomas D. Perry

THE industries which deal with the manufacture and use of lumber continue to display signs of activity in the domain of engineering. It is only a few years since the first intimations were heard that the cutting of trees and the sawing of logs could no longer be considered as a primitive matter, and that natural resources in the line of timber were by no means inexhaustible. Probably because the warnings were thoroughly well founded, they began to attract attention almost immediately, and in due course the lumber industry itself came to recognize the great difficulties which were likely to be encountered both in the obvious and rapidly hastening exhaustion of supplies of standing timber of merchantable grade, and in the equally rapid growth of substitutes which had become vastly popular in the fields of building construction and furniture.

The crusade which the Department of Commerce has undertaken during the last five years for the special purpose of preaching the gospel of economy and efficiency in woodworking, fitted in with, and was an outgrowth of, the alarming facts of our supply of standing timber, and the National Committee on Wood Utilization which the Department set up three years ago has worked steadily—never more so than during the past twelve months—to teach the users of lumber how to treat this precious commodity with fair understanding and how to close the present all too common and deplorable avenues of waste which use and custom have long held to be inevitable. It is fair to say that marked, if not the most remarkable, features of the wood industries situation during 1928 have been (1) the recognition by the lumber industries of the dangers threatening them from exhaustion of supplies and from substitutes, and (2) the adoption by the United States Government, through the Department of Commerce, of a definite policy directed toward obtaining the facts in the premises and discovering, through the cooperative help of the industries concerned, what can be done to ameliorate their effect.

The Wood Industries Division of the Society meanwhile has done its share in the way of cooperation with all branches of the wood-using trades. It has held another national meeting, has sponsored sessions at other stated meetings of the Society, and has contributed papers to the Transactions. Every effort has been made by the Division to secure discussion of all aspects of the engineering of woodworking, if the phrase may be allowed, and the special aim has constantly been to do what can be done toward bringing about among woodworkers the knowledge and experience necessary to aline their methods with those of the most advanced mechanical industries; and simultaneously to assist in carrying into effect, in so far as may have been possible, the work of enlightening the users and fabricators of wood along the lines laid down by the Department of Commerce through the National Committee on Wood Utilization. On this committee sit two representatives of the Wood Industries Division.

During the past year one of the most interesting developments in woodworking has been the steady increase in the use

of dimension stock. The practice is increasing of adapting factory practice to the use of lumber stock cut at the mill to set dimensions and sold accordingly. The practice of packaging such dimension stock is also growing. Naturally, one of the results is an increase in the active work of conservation, since this method permits the utilization of much short-length lumber, and at the same time prevents a great deal of the waste which was and is inevitable when cutting to length is done arbitrarily and without standards. The growth of the practice has not been very rapid but it has been steady and encouraging. Here is one more step practically taken toward the practical conservation of supply and elimination of waste toward which all far-sighted men are looking.

Meanwhile it is to be noted that prices of lumber, save in the case of specialties, remain practically at the same level as prevailed during last year. This may indicate some improvement upon the recently prevailing habit of flooding the market with lumber products in an effort to find outlets for excessive cutting.

In the field of woodworking machinery it is to be noted that the use of the individual motor drive is rapidly increasing. The advantages of this system over belt drive are steadily becoming better appreciated, and today some of the larger machinery manufacturers actually are not making any belt-driven machines.

Another interesting tendency is toward standardization of power requirements. It appears that 60-cycle alternating current of either 220 or 440 volts is coming to be called for by all manufacturers of motor-driven woodworking machines, thus establishing a standard where standards have long been needed. This in turn will undoubtedly lead to standardization of current inputs for manufacturing purposes throughout the country.

More powerful machines with greater development of multiple-operation units are also to be observed as a feature of the year's history in this field. Form cutters and form saws have made their appearance in greater numbers. For cutters and knives, the use of high-speed tungsten steel is becoming universal, entirely supplanting the old-fashioned carbon steel. Grinding and filing of saws has been done to an increasing extent throughout the year by machinery rather than by hand.

In the fabrication of lumber one notes increased use of fancy veneers in the ornamentation of furniture, in marquetry work, and in similar applications. Tropical woods, too, are steadily gaining in this field.

For interior trim in building and in similar uses there is a steady attempt to treat woods so as to make them fire-resistant, or at least fire-retardant. The work is even being extended in some cases to experimentation with furniture, and much good may be looked for during 1929 in this direction.

For finishing wood products, lacquer is being steadily used in ever-increasing quantities, taking the place of ordinary varnishes. Cabinet work, furniture, and pianos are showing especially the effect of this movement.

The influence of modernistic ideas of decoration and design is being increasingly felt through the field of furniture, musical instruments, and so on.

Meanwhile it is interesting to observe that the trade associations concerned with the production and use of wood are coming more and more to the conclusion that they must fight back if they are to withstand the attacks of the manufacturers of substitutes. Campaigns of educational advertising designed to proclaim and teach the advantages of wood over all possible substitutes are being financed and carried out under the direction of the lumber trade associations. It is likely that the tendency in this direction will continue to be intensified for some time to come.

Returning to the technical aspects of the wood industries we note an increasing use of compressed air for driving small tools, and a largely increased use of small electric-motor-driven hand screwdrivers, drills, and saws in various branches of woodworking.

Standardization of operations, interchangeability of parts, the adoption of a common set of norms for threads, bores, and fittings, the classification of all technical names and terms in a common catalog exactly defined and universally recognized, are ideals by no means as yet realized, but it is gratifying to know that some progress is being made toward their realization. In Germany particularly, through the agency of a committee selected by the woodworking trades and operating with the help and under the auspices of the commerce department of the German government, much progress has actually been made in all these directions. The facts were disclosed, for the first time in the United States, through the medium of a paper written by a German expert and read at the Third Annual National Meeting of the Wood Industries Division held this year at Grand Rapids, Mich.

The research activities of the Society sponsored by the Wood Industries Division are coming to a head in at least two directions. The progress report of the Special Research Committee on Saws and Knives is now published and available for distribution. The committee on prevention of forest fires through better methods of spark prevention has now seen completed the three surveys made on the Pacific Coast through the local sections of the Society, and is ready with a preliminary statement on this very important subject. Meanwhile the committeee on additional sources of supply of hardwoods is pursuing its labors under rather discouraging difficulties, but is making all the progress possible in the circumstances. The subject is large and complicated, but progress is being made and the subjects are continually being ventilated.

The woodworking industries are the modern successors of very ancient arts. To turn them into modern mechanized arts obeying engineering rule and practice is not easy; but the movement in the right direction is tremendously powerful. By degrees the work is being accomplished, and it is probable that the researches and the discussions promoted by the Wood Industries Division of the Society are definitely helping to turn the courses of events into the expected and the needed directions.

WILLIAM BRAID WHITE, *Chairman.*

Studying the Constitution of Coal

ONE of the methods of studying the constitution of coal is to examine the results of treating the fuel by organic solvents which, especially at high pressures, extract some of the coal substance. The extract may be resolved into several oily and solid fractions, and considerable discussion has ranged round the question as to whether one of these, and which, is responsible for the coking properties of a coal. It has been questioned whether the extraction made at 285 deg. cent. is purely physical or brings about a decomposition of the coal. Prof. W. A. Bone, L. Horton, and L. J. Tei, according to a paper presented before the Royal Society on November 1, believe that no such decomposition occurs, and in this agree with the observations of other workers who find decomposition setting in only above 300 deg. cent. The extracted matter preexists as such in the coal. The authors found that the soft, oily portion of the extract does contribute to the coking, although this is chiefly bound up with a solid fraction of the extract. From an examination of coals of varying geological age, it was concluded that the oily extracts are obtainable from the younger coals. The counterpart of the solid extract found in the less mature coals is of a phenolic character.—*The Engineer* (London), Nov. 23, 1928, p. 575.

Progress in the Petroleum Industry[1]

Contributed by the Petroleum Division

Executive Committee: Walter Samans, *Chairman*, P. L. Guarin, *Secretary*, T. H. Kerr, H. R. Pierce, C. F. Braun, and W. G. Heltzel

THE petroleum industry has grown so rapidly in the past twenty-five years that, even when considering its progress for one year only, it would be impossible in a brief report such as this to cover in full the outstanding improvements in its diversified engineering interests.

These include the technical activities of the mining, civil chemical, and electrical engineer, as well as those of the mechanical engineer. The various branches of engineering usually included in or considered as offspring of these general classifications, from which experts, each in his own particular line, are engaged in one or more branches of the petroleum industry, are even more numerous.

It is therefore the purpose to cover herein only the principal mechanical engineering developments of the industry, at the same time calling attention to the more general treatment of the industry's problems in the Progress Report for 1927.

Throughout the industry during the past twelve months the overproduction of crude oil and the resultant reduction in the selling price of finished products, due to a highly competitive market, have militated to reduce waste in production, handling, and refining. On first thought this may appear parodoxical, but not when we consider that waste is not intentional but the result of a continuance of obsolete expensive methods when improved methods are known and applicable as a result of wise and reasonable investments. Such improved methods are a necessity to those companies wishing to stay in business without loss, when the overall margins of profit are least.

Whether the methods referred to as expensive are general procedures involving a number of correlated problems or are a single item such as the use of obsolete equipment in one phase of a process, the principles involved are usually subject to study along engineering lines, and provide a fertile field for the engineer's talents.

The last few years have witnessed the greatest progress toward the efficiency goal, because the natural result of increasing the volume of raw and finished products handled coincidentally with the continuance of a high wage rate and high equipment cost, is to make for larger capacities of individual units and the substitution of continuous processes where batch processes were formerly employed. At the same time, the striving toward minimum maintenance costs leads to balanced designs, more careful selection of materials for construction, and careful analysis of the protective measures required to assure the expected life of the plant as a whole.

As far as available time permits, research work is carried on for such purposes, as well as for the discovery of better and more economical processes and the coincidental improvement in quality of products.

The improvements of the past year throughout the petroleum industry are therefore largely developments of those of the preceding year.

Production

The drilling of wells has been carried on in the past almost entirely on a competitive basis; that is, where different persons own interests in the same pool, competition is set up in the rapid drilling of wells too closely adjoining, but on opposite sides of a property line, each person aiming to obtain the maximum amount of oil in the shortest possible time. When a number of large pools are developed in this way, the oil is not only produced in quantities beyond what is required by the market, but the full yield of the pool cannot be obtained, and the rate is most uneconomical.

Under such conditions the necessary equipment is selected and installed with speed as the only consideration. The overproduction resulting has brought these uneconomical methods home to all, for even the consumers of the ultimate products are not benefited when in the end the continued reduction of available supply raises prices beyond their means.

The first remedy considered was the balancing of production with demand, by prorating the desired production among the various pools. A representative of the state commission having suitable powers, or an umpire elected by the producers themselves, dictates what percentage of the potential production is permissible and what new wells may be drilled in. This has not operated as successfully as expected in all fields, but has kept the total production within the maximum possible. However, wherever joint ownership of a pool by the larger companies predominates, or where association of the smaller producers has made it practicable, the restriction of well drilling, together with production control, seems preferable, and should result in maximum recoverable percentages and most economical operation.

At first thought this would seem to have little bearing on purely engineering problems, but as a matter of fact all mechanical operations that relate to production of oil are dependent on engineering principles. The determination and prorating of potential production, the rate of drilling, and other allied operations can be accomplished best by engineering methods.

With the drilling of wells to 4000 ft. and more in depth, larger power units are required, which has emphasized the matter of costs. This has resulted in the adoption of compound steam pumps, and further savings have been effected by the use of feedwater heaters and control equipment, as well as better insulation, in steam plants.

Where electric power is available—and the power companies have rapidly extended their service in plant and transmission lines—its use will save about three-fourths of the power costs of drilling and pumping as compared with a simple steam plant, and about one-half in the case of a better steam plant and compound steam pumps.

These economies are especially available in the Mid-Continent field, where deeper wells are drilled than on the Gulf Coast and in California. In the Greater Seminole pool in Oklahoma, an electric-driven slush pump having duplex fluid cylinders of $7^1/_4$ in. diameter by 18 in. stroke, requires a 150-hp. motor to handle the mud-laden fluid weighing 90 lb. per gal. at pressures up to 450 lb. These large pumps have been on the market only a short time, as the shallower wells formerly drilled required equipment of but half their capacity.

As the result of the better pumping equipment developed during the past year, we now have the electric pumping-gear set and the chain-driven pumping set with tug rim and chain-driven sand

[1] The chairman is indebted to the members of the Committee for assistance in preparing this report.

reel, which readily do the work formerly accomplished with older band-wheel equipment. Counterweighting the well-pumping units makes them run more smoothly.

STANDARDIZATION OF PRODUCTION EQUIPMENT

The need of uninterrupted drilling operations in the development of new oil pools, as well as the economical desirability of uniform practice and interchangeable equipment and parts, resulted in the formation of a Standardization Division in the American Petroleum Institute. The work of its committees has been in progress for six years, and about 90 per cent of it is completed. Complete specifications have been adopted on all classes of tubular goods, including casing, drill pipe, tubing and line

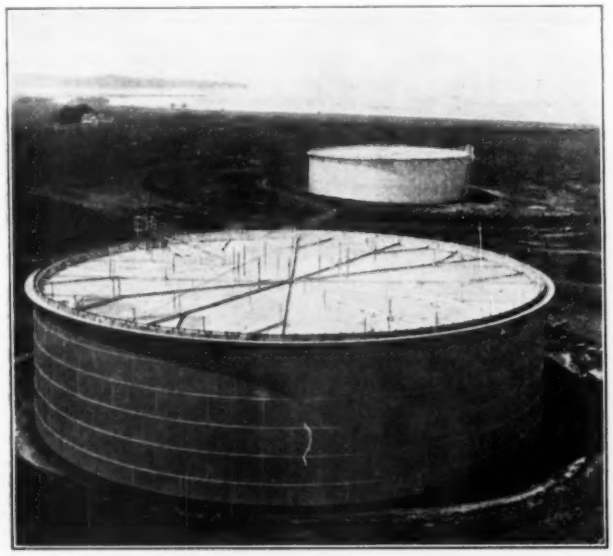

FIG. 1 TWO TANKS 115 FT. IN DIAMETER EQUIPPED WITH FLOATING ROOFS

pipe, and on firebox boilers, cable-drilling tool joints, and standard rigs and derricks, both all-steel and combinations with wood. Specifications on rotary equipment, pumping equipment and engines, well rods of various types, motor frames, belting, wire rope, and manila cordage have been issued in part. Complete specifications for purchase, fabrication, and erection, with full detailed shop plans and rivet lists, are now available for steel tanks for oil storage in all required standard sizes.

NATURAL GASOLINE

The production of natural gasoline, as is well known, has always been a factor accompanying the drilling of oil wells. Natural gas is found in all oil pools in varying quantities and under varying pressures, both decreasing as the pool is developed, until finally, when the recoverable oil may be exhausted, the gas is drawn from the wells under vacuum. Depending upon its source, the natural gas contains as absorbed vapors the lighter hydrocarbons, which are in turn recoverable from the fixed gas by the absorption method, in which the rich gas is bubbled through an unsaturated oil of selected quality and boiling range, the absorbed gasoline being later reevaporated by heat and separately condensed; or the rich gas is compressed, and in the after-cooling the condensed gasoline vapors are separated from the fixed gas by draining off. Again the rich gas may be relieved of its natural gasoline commonly called "stripping," by the combination of a compression and absorption plant. A similar process is used in the refineries for stripping the gas released in distillation and cracking processes, and commonly known as "still gas."

Besides the problems presented by the physical and mechanical processes used in reclaiming the natural gasoline, there is the chemical reaction of corrosion, due mainly to hydrogen sulphide, to combat which mechanical troubles must be solved and materials for the equipment employed must be carefully selected. This will be discussed later under the heading "Corrosion."

The return to the compression gasoline plant has been generally due to the undisputed success of this method of operation for performing the dual function of gas lift and gasoline extraction. The one unfortunate result of the general adoption of this type of plant was an excessive production of natural gasoline during the early part of 1928 which forced prices to lower levels than ever before experienced. However, through a greater degree of appreciation of the economic situation this surplus condition has for the most part been corrected.

Probably the greatest advance in prime movers for gasoline-recovery plants during the past year has been the material improvement in high-speed medium-duty gas and oil engines. These are now being produced by several companies and are giving satisfactory results on variable-duty semi-continuous

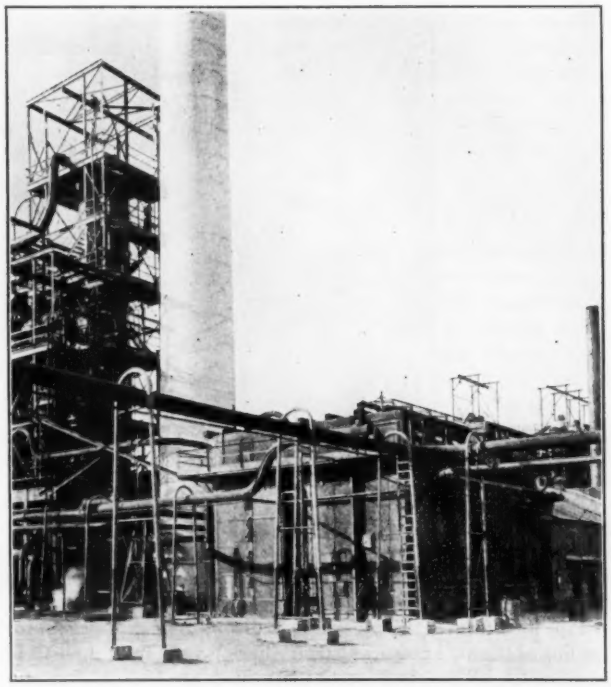

FIG. 2 CRUDE FRACTIONATING STILL, SHOWING FOSTER HEATER, STACK, AND BUBBLE TOWERS

service, and in many cases on constant-duty continuous service.

One of the outstanding events of the past twelve months was the opinion handed down by two United States district courts in relation to the validity of the so-called Thompson rectification patents. These laid claim to the invention of processes and products that had been in use and had existed for many years prior to the time of their filing by the patentee. As a result of the litigation, it was natural that considerable attention should be directed to rectification, and in a great many cases where not previously in use this system has been adopted in preference to the old one of weathering and recycling, which accomplished the same results but sometimes at a higher cost.

Last year attention was directed to the fact that the use of automatic controls and labor-saving devices had received a great impetus. The application and improvement of this equip-

ment have been widespread during the past year, until now the most complicated operations are entirely accomplished without manual intervention. Much remains to be done in the further improvement of these devices and their utilization, and probably there will be somewhat of a reaction from the unnecessary use of some types of such equipment.

TRANSPORTATION

Crude oil is transported from the field to the refinery by pipe lines or by tank ships, commonly known as "tankers," or by a combination of these two facilities, depending on the relative location of the fields. In a few instances railroad tank cars are used for bringing crude oil from field to seaboard loading stations, but this only where doubt as to continuance of production does not warrant the construction of a pipe line, as the cost of railroad transportation is naturally higher.

Pipe lines from gathering points to distant refineries or seaboard loading stations, known as "trunk lines," vary from 6 to 12 in. in diameter, although the more recent lines are 10 in. in diameter. The pumping stations are located at intervals of 20 to 70 miles, depending on the quantity and viscosity of the crude to be handled and the nature of the terrain crossed.

Formerly lap-welded steel pipes with screw couplings were laid on the surface of the ground or under a shallow earth cover, and little attention was paid to protection from soil corrosion. During several years past the jointing of lines by acetylene welding on chamfered ends has been gaining in popularity, and now there is scarcely a line laid that is not welded. The pipe manufacturers have cooperated by furnishing pipe in 40-ft. lengths, double the usual dimension. Electric welding of pipe lines in the field is now being tried, and automatic welding may be expected. Seamless steel pipe is coming into use, which has permitted greater pumping pressures. One of the outstanding examples of this kind is the first 8-in. line extending from Wink, Texas, to El Paso, Texas, laid in the past year by the Pasotex Pipe Line Company; this line is operated at 900 lb. pressure.

With the laying of larger pipe lines in greater number, and the discovery of weakness in existing lines due to corrosion, necessitating the emergency replacement of many pipe lines in active service, more attention is being given to protection from soil corrosion. This will be discussed later.

Up to within recent years the pipe-line station was as elementary as conditions seemed to warrant. Oil-field boilers, many of the locomotive type, were fired with crude oil as fuel, and supplied steam at moderate pressures to simple steam pumps. Fuel being abundant, little attention was paid to efficiency; the lagging of boilers was haphazard, and the insulation of steam lines comprised a simple rain shed and the cheapest possible pipe covering, if indeed any protection was afforded.

These earlier installations, some of which are still found in use, gave way to horizontal power-driven pumps of two or more cylinders or vertical triplex pumps, the pumping pressure being nominally about 700 lb. For these the motive power was an air-injection oil or gas engine. Later, solid-injection oil engines of both vertical and horizontal types were used. At many of these stations a steam plant was built as a reserve. The engineering work on these plants was, however, first class.

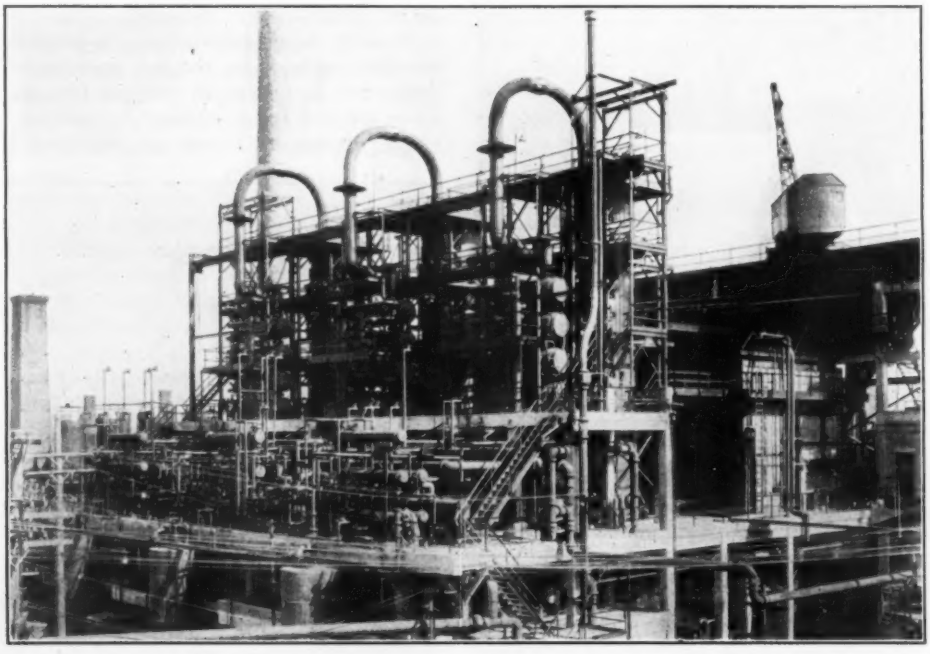

FIG. 3 A BATTERY OF THREE CRUDE-OIL FRACTIONATING STILLS. NOMINAL CAPACITY, 10,000 BBL. PER DAY

As the oil-pool territory became populated by reason of extended developments, power companies saw their opportunity, and now even in the newer fields it is possible to obtain alternating current from high-voltage lines stepped down to the voltages required. While centrifugal pumps have been used for years in transferring oils at moderate pressures, and particularly on the Pacific Coast, there was a basic objection to their employment on the small capacities of the early pipe lines at the pressures required, which at that time could not be obtained at reasonable efficiencies from the multi-stage pump designs then available; and there was also the variable rate in pumping to be considered.

At the present time, and particularly during the past year, centrifugal-pump installations have been made for pumping petroleums having a wide range of gravities and viscosities. In some cases the application of the centrifugal pump was made possible only by obtaining reasonable viscosities either through the heating of the high-viscosity oils or by blending them with

lighter-viscosity oil before entering the pump. Under these conditions operating pressures ranging from 600 to 1000 lb. are employed. There are, however, certain limitations to the use of centrifugal pumps, in that they are normally only comparable in efficiency with reciprocating power pumps when operated at designed capacities, pressures, and gravities of oil, with moderate viscosities. At low capacities, even if so designed, or at viscosities over 300 sec. Saybolt Universal, the efficiency drops off rapidly. It is also necessary to replace the wearing rings of impellers as wear develops, otherwise the efficiency will fall off materially.

The advantages of the centrifugal pump lie in its use as a spare pump to keep down the first cost of main stations, and as a booster pump between main stations on trunk lines where a temporary increase in line capacity is required for flush production.

For main-line-station pumping under the usual economic considerations, an electric-motor-driven centrifugal-pump installation must maintain an average overall efficiency of 68 to 70 per cent to be competitive with an electrically driven reciprocating pump. With oils of limited viscosity this seems quite possible where new pumps on test show 80 per cent efficiency or more. It should also be remembered that centrifugal-pump installations can be more readily and quickly installed or removed.

Steel storage tanks, both on pipe lines and at seaboard loading stations, were for many years standardized on a size of 55,000 bbl. each or 115 ft. diameter by 30 ft. high. Within the last few years pipe-line tanks on new installations have been reduced in size to act mainly as surge tanks, and a recent installation in West Texas using pipe-line centrifugal pumps, has installed 1000-bbl. tanks for this purpose; meanwhile on seaboard loading stations and tank storage farms the standard size has increased to 80,000 bbl., and at present there are under construction a number of 120,000-bbl. tanks. While floating roofs have been extensively used on storage tanks both in the field and in refineries, the past year has witnessed the successful operation of a "breather" roof. This type of roof was primarily intended for full storage, and consists of an assembly of rectangular plates $^3/_{16}$ in. thick, fastened to the shell of the tank by a ring angle in the usual way with all seams welded. The original intention was to let the roof sag down on supporting beams provided as the tank was first filled; then, as the temperature rise caused the vapor space to expand the roof would rise until the camber was equal in amount to the original sag (about 9 in. from the neutral horizontal), at which point excess pressure would be relieved through a vent valve actuated mechanically. When the tank was emptied or contraction of the vapor space due to cooling caused the roof sheets to drop to the supporting beams, a vacuum relief valve would open.

It was found that by keeping the oil high enough in the tank and in contact with the roof so as to slightly raise the latter above the neutral line, the evaporation losses were negligible, with reduced corrosion on the underside of the roof sheets. This corrosion, from past records, had been very noticeable, particularly for high-sulphur crudes of West Texas.

The transportation of crude oil by tanker has naturally developed with the production in territories within pipe-line distance of tidewater. At present, oil is so transported from California and the Gulf Coast to the Atlantic Seaboard refineries, as are also some foreign crudes, noticeably from Venezuela, and to a lesser degree from Colombia and Mexico.

As in the case of other equipment of the industry, the size of tankers is increasing, and a noticeable trend to Diesel-engine propulsion has taken place. While direct drive to the propeller shaft is favored by many because of its efficiency and simplicity, a number of Diesel-electric-drive tankers are in use, particularly by one large Eastern company which believes that greater flexibility, pilot-house control, and maneuvering ability offset the slight gain in long-voyage efficiency claimed for direct Diesel propulsion.

Refining

During the past twelve months there has been a continuance of the improvements started in the previous year, not only on unfinished installations but by modification of old plants.

On pipe fractionating stills, the addition of side-stream strippers has resulted in the elimination of light ends or tails in the distillation curve.

In one installation the attempt has been made to increase the heat recovery by the installation of vapor heat interchangers between each pair of fractionating trays. In towers of more conventional design, the number of vapor heat exchangers is limited to the number of side streams removed, and in single-flash, single-bubble-tower operation on crude oil is often limited to exchange with the naphtha vapors. The resulting temperature of the crude rarely exceeds 425 deg., as compared with the claim for the newer method of 500 to 550 deg. It is also claimed that the changed reflux conditions brought about result in no decrease in efficiency of fractionation.

The refining of the high-sulphur crudes produced in West Texas has added to the corrosion problem in fractionation equipment, both in the pipe coils and other high-temperature portions of the stills, and in condensing and cooling equipment for the light ends. This trouble is being combated both by blending with other crudes before charging, and by caustic soda or lime treatments applied at the charging pump.

The construction of liquid-phase cracking equipment has continued, due to the normal annual increase in demand for motor gasoline, and the capacities of the units have been materially increased by charging a mixture of hot recycle stock from the base of the bubble tower and fresh charge, the pump drawing from the base of the tower or separate mixing tank, depending on the process followed. By this method crude oil can be charged direct to cracking stills, and the natural gasoline taken off with the cracked gasoline. Of course, crudes high in lubricating stock are not so distilled. The details of the equipment used in running crudes this way depend upon the particular patented process for which the apparatus was built.

Vapor-phase cracking plants are increasing in number because of the anti-knock value of gasoline so produced. The refining losses may be kept within reason if properly controlled.

The Edeleanu process for the refining of lamp oils and lubricating oils is continuing to find favor.

The contact filtration process of refining lubricating oils has made little progress during the year.

The number of centrifuge plants for dewaxing has increased.

Vacuum distillation in connection with lubricating-oil refining is receiving more attention.

There have been no new developments in shale-oil distillation, mainly on account of the overproduction of ground crude.

Corrosion

Corrosion, mainly due to sulphur and chlorides, is prevalent in all equipment used in the petroleum industry from the well up to the last stage of refining the products.

A year or so ago an estimate based on preliminary study placed this loss at about $120,000,000 annually. The American Petroleum Institute authorized the formation of a General Corrosion Committee, which first met in February, 1928. This committee has been collecting data on the subject and is endeavoring to obtain more accurate records from the various oil companies and individuals therein who are combating this evil.

The three methods of correction most commonly employed, singly or in combination, are: the use of parts made of corrosion-

resisting alloys; surface protection, which is usually electroplating, hot-process metallic coating, such as calorizing, or spray coating of metals; and the injection of chemical neutralizers into the charging oil if for the protection of still apparatus.

In production, oil-well tubular material and rods have been tried with aluminum and chromium alloys entering into the parts most affected. Chemical treatment of the corrosive gas and natural gasoline produced therefrom has been effectively handled both by the introduction of anhydrous ammonia in the gas stream and by means of a wash of caustic soda.

Steel storage tanks in the field, at loading stations, and refineries have been built with roofs and sometimes top ring sheets of pure iron or copper-bearing steel, with rivets of similar material. Aluminum alloy has been tried for this purpose, but is not considered favorably as yet on account of the expense.

Various kinds of paints are being tried on the interior surfaces of roofs for protection against hydrogen sulphide. Other paints and plastic compounds are being tried on the inside of bottoms for protection against salt water containing sulphurous compounds.

Pressure and vacuum relief vents on tanks, ordinarily provided

FIG. 4 REACTION CHAMBER FOR OIL-CRACKING STILLS
(Finished weight, 51 tons; operating conditions: 750 lb. pressure, 850 deg. fahr.)

with flame arresters, are being universally adopted. These are made of aluminum or are combinations of cast-iron housings with working parts of aluminum or brass, and lead-coated plates, depending on conditions to be met.

In connection with pipe lines, two practical methods of protection are in general use. One is the application of a paint alone, and the other that of a combination of a protective liquid coating with a fibrous wrapping material. Various paints and compounds are recommended by manufacturers and a number are being tried, but field application in any case requires a thorough preparation of the surface to be covered, and the application of the protection may be difficult due to necessary haste and weather conditions.

In order to do away with most of the field work, some of this coating is now done at the mill or at a point of distribution near the proposed pipe line where the pipe is unloaded from cars and temporarily stored. A satisfactory coating must be water-tight and have a certain amount of mechanical strength, on account of the handling of the pipe, and at the same time it must be resistant to the chemicals in the soil, which vary in character in different localities.

A series of soil-corrosion tests has been run by the Bureau of Standards during a number of years past, and it is planned that a report thereof in the form of a paper will be presented at the Annual Meeting of the A.P.I.

As regards equipment in refineries, the aim is to obtain protection against corrosion by using materials which are not too expensive and which will extend their life in proportion to that of the whole equipment so that shutdown periods will not be longer than the normal time permitted for cleaning when replacement of corroded parts is made.

In the case of distillation apparatus the great difficulty seems to

FIG. 5 A BATTERY OF SIX CROSS-CRACKING STILLS (FOUR IN VIEW), SHOWING REACTION CHAMBERS WITH STEEL-JACKETED INSULATION; LOCATED PARTLY OVER ROOF OF PUMP HOUSE

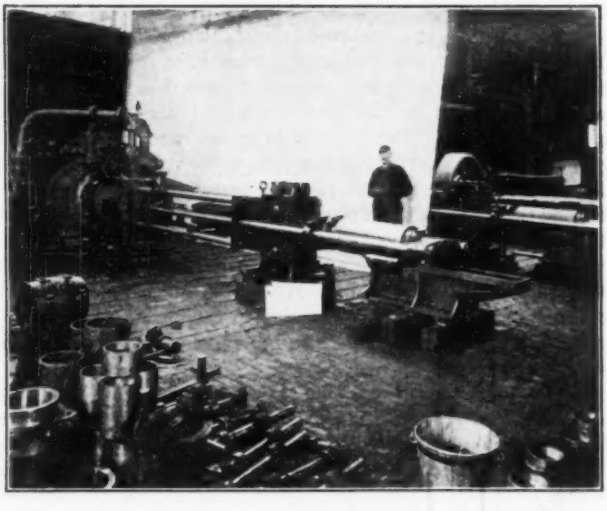

FIG. 6 HOT-OIL CHARGING PUMP FOR OIL-PRESSURE STILL
(600 deg. fahr., 1400 lb. per sq. in. pressure.)

be that the combination of temperature and pressure at which corrosion takes place also has an effect on the strength of corrosion-resisting alloys. The chromium alloys for this purpose are very expensive, and the results obtained in experimental installations are not by any means uniform. It is not the purpose here to refer to all refining conditions where various types of corrosion-resisting metals, protective coatings, and neutralizers have been tried during the past year; suffice it to say that, in general, coatings are not of permanent value, particularly where the materials coated will be subjected to mechanical manipulation afterward.

The problem is metallurgical as well as chemical, but at least progress is being made in solving the difficulties. It is expected that the progress report of the A.P.I. Corrosion Committee will be available early in 1929.

In connection with progress in the Petroleum Industry, one should not overlook the opportunities for young graduate engineers, particularly those with mechanical and chemical training.

For every technically trained engineer in the industry twenty-five years ago there are now fifty with similar training and who, on the average, possess a more extensive practical knowledge and a broader viewpoint as a result of the rapid growth of engineering knowledge during that period, both in theory and its practical application.

While a similar statement might be made for the railroad industry of the United States, which compared with the petroleum industry has twice the valuation, or for the steel industry for which the valuation claimed is about half that of the petroleum industry, it cannot be said that the processes of production, manufacture, or operation and distribution have been so recently and completely revolutionized in these other two large industries as in the petroleum industry.

The great accumulation of experience and the knowledge based thereon that has been gained in the past is now being successfully applied as never before. And the cooperation, particularly on common problems, between the various branches of the petroleum industry through established forums promises a widespread influence for the betterment of the entire nation.

WALTER SAMANS, *Chairman.*

Progress in Fuel Utilization in 1928

Contributed by the Fuels Division

Executive Committee: Victor J. Azbe, *Chairman*, Wm. G. Christy, *Secretary*, E. C. Schmidt, John Van Brunt, R. T. Haslam, and Geo. A. Orrok

IN ALMOST all phases of fuel utilization the past year has been characterized by consistent development of methods previously introduced and of equipment, the use of which had already been initiated. The greatest advances have been made in those branches of fuel utilization in which the largest quantities of fuels are employed. However, the predominant tendency to increase the effectiveness of fuel-utilization processes generally has caused an increasing amount of attention to be paid to combustion processes in those industries which have hitherto not shown active progress.

The report of this Committee is intended to summarize the more important advances which have been made during the past year. So many detailed improvements have been noted, however, that for a more complete statement reference must be made to the appended bibliography.

Specific attention must be drawn to the very valuable material reported at the three principal symposia on fuels conducted during 1928; namely, the fall meeting of the Fuels Division of the A.S.M.E. in Cleveland, the Fuels Conference of the World Power Conference held in London, and the more recent Second International Conference on Bituminous Coal in Pittsburgh. The transactions of these three meetings are replete with the most advanced material of interest to those concerned with fuel utilization.

PRODUCTION, PREPARATION, AND STORAGE OF FUELS

Bituminous coal is the principal source of energy for the generation of power. Such an industry should be characterized by stability, constant output, and consistent earnings. Its present condition, on the contrary, is not far from one of distress. The maximum producing capacity of the bituminous-coal industry is variously estimated to be from 700,000,000 to 850,000,000 net tons, and shows no steady rate of increase. The production data for the period 1925–28 clearly indicate the present trend.

Year	1925	1926	1927	1928
Net tons	520,052,741	573,366,985	517,763,352	500,000,000 (estimated)

Comparative data indicating the relative use of coal are available for only a few industries. Those for central stations, however, show the present tendency.

	1927 Jan.–Aug.	1928 Jan.–Aug.
Energy generated from fuel, 1000 kw-hr.	29,556,431	30,941,071
Coal used, net tons	23,638,154	23,914,597
Fuel oil used, bbl	4,414,761	4,219,881
Gas used, 1000 cu. ft	38,454,403	47,280,154

The only material change noted is the increase in the use of gas. The figures for the last four months of this period show a decrease in coal used, and marked increases in oil and gas used for power generation in central stations. The increase in total energy generated in central stations noted elsewhere is due to a steady upward trend in the amount of power produced in the hydroelectric plants.

COAL-PRODUCING METHODS

In the mining of coal the efforts to reduce production costs and increase the percentage of recovery have been vigorous. This work has largely centered in the more extensive use of mechanical cutters, loaders, and conveyors, and in the adoption of improved mining systems. New types of mining equipment of practically all kinds have been introduced, and the older ones have been improved. Of particular significance is the work along these several lines by the larger coal producers. Much interest is being displayed in the development of a CO_2 cartridge for shooting the coal, a method which would eliminate flame. An outstanding activity is the increased attention paid to safety measures. The problem of supplying bituminous coal on a basis of quality and adaptability to specific purpose or type of combustion equipment has attained major importance, and hence producers are paying much attention to methods of cleaning and preparing coal. The labor situation in the bituminous industries is satisfactory, and there are no indications of potential strikes.

ANTHRACITE

In the anthracite industry cumulative production for the first seven months of 1928, as compared with the corresponding period of 1927, shows a decrease of 4,500,000 net tons. Competition from oil and coke is severe. The decrease in production

has caused the anthracite mining companies to make more intensive efforts to improve mining methods and to add labor-saving equipment. Old and expensive workings are being abandoned, and the larger mines are being equipped with automatic machinery in place of the old equipment. Extensive changes in auxiliary appliances are being made. The organization of the anthracite operators to carry on a well-planned research program, which has been effected, is undoubtedly an event of far-reaching importance in this industry. The anthracite industry has definitely started a series of investigations, the purpose of which is, first, to increase the efficiency of utilization of anthracite fuel generally, second, to develop means for applying steam sizes of anthracite to domestic use, and third, to carry on investigations which will enable the anthracite industry to turn some of its output into materials of greater value. The industry is having the close cooperation of domestic-heater manufacturers, and it is believed that this work will result in a distinct increase in the use of anthracite for domestic heating.

Coke

By-product coke for the first eight months of 1928 showed an increase of 2,000,000 tons over the same period for 1927. Beehive-coke production dropped 2,500,000 tons, and the net production is just under the figure for 1927 for the corresponding period.

Liquid and Gaseous Fuels

The increased use of natural gas for power generation has been referred to. During the past year at least three large gas lines have been completed which bring natural gas in increasing quantities into such centers as Denver, Omaha, and Kansas City. Considerable effort is being made by oil and gas producers to reduce the tremendous wastage of natural gas which has occurred and to divert it into domestic use, power generation, and to the repressuring of oil wells. This fuel is now being found in such large quantities that the fears felt some years ago for its rapid extinction no longer exist. Production of crude petroleum for the first ten months of 1928 has been 4 to 5 per cent under that for the corresponding period during 1927. A very concerted effort was made to control petroleum output in the United States, both as a means of conserving this natural resource and as a necessary method of insuring the financial stability of the oil industry. At the present time the known oil reserves of the world are greater than at any other time. The petroleum industry is still in a critical state as far as the regulation of the supply of crude petroleum is concerned, and the efforts made this year to cooperatively hold down production in the U. S. must undoubtedly be extended to the principal foreign producing districts.

Furnaces

No radically new types appear to have been developed during the past year, but distinctive development along two lines has taken place, i.e., the further extension of water- and steam-cooled wall surface, and the decided increase in the use of automatic combustion-control equipment. Increased water cooling of the walls through water screens, which are a part of the boiler circulatory system, or by the use of radiant superheaters is taking place, because such development is found to reduce furnace maintenance costs and to facilitate improved combustion. Refractory surfaces continue to be used in the smaller installations, and particularly when the use of certain varieties of fuel is required. Furnaces with air-cooled walls are still being built, but operators believe that this type of wall will be gradually superseded by the water-cooled type, despite the higher cost of the latter.

Stokers

Reports from manufacturers indicate that the principal changes in stoker design which have taken place during the period covered by this report are: first, strengthening of those parts subject to strain by substitution of steel for cast iron; second, increase of the ruggedness of the ash-disposal mechanisms; and third, increases in both length and width. Last year this report mentioned the trend toward specific control of air admission to different parts of the fuel bed. This trend has continued uninterruptedly, and the newest stokers are being supplied with air-control systems intended to permit highly selective admission of air to the different portions of the stoker. Moreover the advantages of controlled supplies of air over the fuel bed are now thoroughly appreciated, and many such installations are being made. The burning of low-grade and clinkering coals at high percentages of rating on stokers has been successfully carried out by means of stokers specifically designed for this type of operation. The limit for air preheat in ordinary installations continues to be 400 to 500 deg. fahr., although the presence or absence of an air preheater in a given installation is dependent on the particular heat-balance conditions of a given installation. Corrosion of air preheaters which has been experienced has been eliminated by increasing the exit gas temperature, and the burning of stoker tuyeres has been corrected by using greater clearances and in some cases using coal with a higher ash-fusion point. A great deal of attention is being paid to tuyere and retort design, notably in altering the tuyere-to-retort area ratio, the overfeed-underfeed ratio, and the use of large rams with variable-width tuyeres. Sufficient data are now available so that stoker manufacturers are designing equipment with constantly increasing exactitude.

This year has seen a real tendency toward the installation of mechanical stokers in marine practice, and this type of equipment is being tried out in a sufficient number of ships to indicate that progress in this direction from now on will be rapid. The trial installations seem to be proving successful.

Pulverized Fuel

The increased use of pulverized fuel both in converting old equipment and as regards new installations continues at about the same rate as for the preceding year. In public-utility plants the central storage system predominates over the unit system in the ratio of 2.4 to 1, whereas in the industrial plants the installed horsepower supplied by the unit system is greater than that of the central system in the ratio of 1.7 to 1. The rate of increase of the unit system has been greater than that experienced by the central system, and a few installations of the unit system have been made in connection with large boilers. The use of preheated air in the mill for drying coal seems to be prevalent in new installations, except for those fuels which have a low ignition point. In these cases the use of steam for drying reduces the tendency to take fire in the drier. The elimination of dust in the stack gases from pulverized coal is giving concern in a great number of cases. This problem is being attacked in a variety of ways, e.g., by the use of cyclone collectors in series, water sprays, electrical precipitation, etc. As may be expected no one method seems to be uniformly applicable, and the particular means used have to be specifically selected for each installation. Installations have been made in which the regular bank of boiler tubes is protected by an extra series of tubes on extended centers below the regular bank as a means of chilling the ash in such a way that it does not cause slagging on the boiler tubes. This method may prove to be of particular advantage in small furnace chambers where short-flame burners are used. No new significant points in the design of furnaces for use with pulverized fuel are noticed, the trend being the same as for

stoker-fired furnaces in that the use of water- and steam-cooled walls practically enclosing the combustion space is almost universal.

The more extensive use of the turbulent-type burner referred to last year continues to be noted, the principal advantages being increased combustion rates per unit of furnace volume, reduction of excess air, and facilitation of ash separation.

The turbulent-type burner has been successfully applied to Scotch marine boilers. While the extension of the use of pulverized fuel to marine practice in the United States has been slowed up by the low prices of bunker fuel oil, it is certain that interest abroad in this development is constantly becoming more intense. On at least three British ships at the present time a part of the boilers are being fired with pulverized fuel. The bunker-fuel situation in England will encourage intensive work to perfect the use of pulverized fuel for cargo carriers. The British government is expected to appropriate £100,000 for such development during the coming year.

Steam Pressures

Aside from the fact that additional 1400-lb. units have continued to be built, no radical change has taken place in steam pressures and temperatures, although in the larger stations the trend seems to be from the 400-lb. to the 600-lb. range. A consistent realization of steam temperatures of about 750 deg. fahr. has not yet taken place.

Two-Fluid Systems

In last year's report the possibility of the bi-fluid system, using organic compounds of the type of diphenyl oxide as a substitute for mercury, were indicated. Research work carried out during the past year has indicated that whereas the thermal stability of such compounds at operating temperatures can be assured, the peculiar thermodynamic properties of such organic liquids requires the use of such large heat-exchange equipment that the necessary capital cost of the equipment is so high as to render the use of an organic-boiler-fluid system non-competitive with the 1400-lb. steam system at present.

Locomotive Practice

In this field the selection of fuel has been one of the major means of conserving fuel. The pounds of coal per thousand gross ton-miles continues to decrease at the rate of about four per cent per annum, and the corresponding figure per passenger car-mile is decreasing nearly two per cent. The number of locomotives in service which are equipped with mechanical stokers has increased until about one-fourth of the total number have stokers installed. Over one-half of the total number of locomotives employ superheaters, and the use of automatic fire doors on locomotives is now general practice. Railroads are paying particular attention to the proper selection of fuel and to supplying divisions constantly with the same kind of fuel. This permits effective training of firemen.

A great deal of interest is displayed abroad in the Schmidt high-pressure locomotive which employs two steam pressures, 850 lb. and 205 lb. The 850-lb. steam is expanded in a center cylinder, the exhaust from which is mixed with the 205-lb. steam, which is then expanded in two outside cylinders. This development has presaged the building of additional locomotives to operate on a similar principle, in that the high-pressure portion will be further enlarged at the expense of the low-pressure system. In addition a locomotive working at 1700 lb. pressure according to the Loeffler principle is now under construction. The advantages for this particular design are fuel economy, with only slightly higher first cost than that of existing locomotives. In Russia particularly, as well as in other European countries, the application of Diesel engines to railway work continues. This is being facilitated by a solution of some of the difficulties of gear transmission previously experienced.

Gas Manufacture

This field of fuel utilization is becoming distinctly interested in two auxiliary processes, namely, the dry quenching of coke and the dehydration of gas. The economical advantages incident to using the sensible heat of the coke for producing steam are beginning to be appreciated as the success of existing installations becomes better known. This type of plant is adaptable to a large variety of carbonizing units and conditions, and the facts indicate that the dry-quenched coke produces less breeze and has some advantages as water-gas fuel over water-quenched coke.

Meter repairs have always been an appreciable item in the cost of manufactured gas. Data gathered both in the United States and England indicate that substantial savings on this item may be made by dehydrating the gas before distribution. Certain processes for dehydration are being installed in the United States, and the forthcoming year should produce data really indicative of the value of these processes. Research in England has indicated that specific constituents of the ash in coal may have significant effects on the properties of the coke in so far as its ability to decompose water and CO_2 are concerned. The practical aspects of this point remain to be investigated.

Low-Temperature Carbonization

The Second International Conference on Bituminous Coal at Pittsburgh brought forth many papers and considerable discussion of this topic, and still there do not seem to be definite data establishing the economic utility of this process. Until the two large-scale plants in the United States have operated for a sufficient time to demonstrate the earnings possible, little real progress can be reported. The theoretical as well as the engineering aspects of low-temperature carbonization are doubtless well worked out, but it is believed that even in England where the market for low-temperature coke should permit of a higher premium than in the United States, definite assurance as to commercial practicability seems to be lacking. The value of the tar seems to be a doubtful point. It is possible that low-temperature tar could be hydrogenated to produce such a large proportion of saturated hydrocarbons that its value could be greatly enhanced with a consequent improvement in the economic situation of the process as a whole. Continued experimentation both in the United States and abroad proceeds, as well as continued discussion of the general scheme of combined gas and electric plants. A paper by Rosin at the World Power Conference summarizes the possibilities and draws the conclusion that the combination has the best chance of economic success when low-grade fuels such as lignite are used.

Experimental work on low-temperature carbonization processes both in the United States and abroad is being actively continued on a wide variety of processes, most of which have been described fully in the literature. Taken as a whole this work is being supported financially to an extent almost unequaled in any other branch of the fuel-utilization field.

Smoke Abatement

The necessity for smoke abatement in the large cities is constantly becoming more acute. Data as to the economical losses and health hazards involved are becoming more available, and a few of the more progressive municipalities are adopting smoke-abatement ordinances and instituting control organizations to the end that only combustion equipment designed for minimum production of smoke will be permitted and that

constant effort will be made to modify existing installations. Notwithstanding this interest there is as yet no effective or uniform means available for controlling or abating the smoke nuisance.

RESEARCH

Despite the interest in this phase of fuel utilization displayed at such meetings as the Second International Coal Conference and the fact that The American Society of Mechanical Engineers, the American Gas Association, National Coal Association, and other similar organizations have research committees and tentative research programs, no concrete organization fully organized to secure the necessary funds for carrying on a well-considered program of fuels research has yet been developed. This is probably the greatest single need in fuel utilization at the present time.

The papers presented at the conferences noted above constitute quite a comprehensive statement of the work completed and under way.

Mention of even the subjects discussed at the Second International Conference on Bituminous Coal would be too voluminous for this report. The impression gained by those attending the sessions was that throughout the whole world an enormous amount of well-chosen and well-conducted fuels research is being carried out. Abroad the greatest importance is attached to transformations of coal and its derivatives into materials of enhanced value such as liquid fuels.

Without minimizing in any way the importance of the other papers recently presented, attention should be called to two papers vitally affecting furnace design, namely, those by Wohlenberg and Anthony, soon to appear in the publications of the Society; and by Rosin at the Second International Conference on Bituminous Coal.

Some of the more important work being carried on in Europe on which definite progress seems to be assured includes:

Development of Internal-Combustion Engines Using Pulverized Coal as Fuel

Application of Pulverized-Coal Firing to Locomotives

Long-Distance Transmission of Coke-Oven Gas

Formation of Benzol and Other Hydrocarbons from Methane.

Details of the work done on these projects will be found in the transactions of the Second International Conference on Bituminous Coal.

J. T. WARD,[1] *Chairman*,
Progress Report Committee.

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[1] Associate Professor of Fuel and Gas Engineering, Massachusetts Institute of Technology, Cambridge, Mass.

Research in the American Coal Industry

OF WHAT use can research be to the coal industry? If we assume a great interest in the subject by the managers of the large properties, can they hope to obtain from such interest any help in solving their problems that will be worth while, and will repay the time and money required?

Research into the composition of coal in Germany has resulted in the production of oil from coal, a process now reaching the commercial stage, and in that country and in France several other important chemicals have been produced directly from coal; various methods of processing coal for its better utilization as gas and smokeless fuel are now nearing the utilitarian stage; the many by-products obtained in coke making are a familiar example.

Research of the practical kind has produced the excellent electric lamps now largely used in mine work; an electric gas detector used in examining mines, instead of the ordinary flame lamp ordinarily used; the many kinds of gas-proof machines for use where explosive gas is encountered; the short-flame, or permissible explosives, now largely used; a metal for use in pumps, which has greatly reduced the maintenance of such machines; and many other things that have tended to increase the safety, or reduce the cost, of mining.

A coal-research program, to be of interest to the industry at this time, must consist largely of investigation into problems of a practical nature, but with this should be combined pure research into the composition of coal, as many of the practical problems can only be permanently solved by the use of information obtained by the latter, and definite knowledge of the physical and chemical characters of our coals will lead to the solution of many pressing problems. The two lines of work should march together, the pure research work in the lead, with the other work playing the secondary (but more important commercially) part of helping the industry forward.

The pure-science research on the constitution of coal should determine the physical structure and the chemical compounds that make up the coal substance, how peat is converted into the lowest rank of coal, how that rank is metamorphosed into higher ores, and what are the factors influencing the making of coke; if all of these things were known, the solution of many practical problems involving gas making, spontaneous combustion, smokeless fuels, etc., would be greatly simplified.

The applied research work should determine some method of recording the presence of explosive gas in a place, and automatically give warning when it reaches a dangerous limit; some way of foretelling, or preventing, the occurrence of outbursts of gas; methods of accurately determining the origins of mine explosions; an economical permissible storage battery; a good system of mine lighting; a method of preventing noises from machinery so that roof warnings can be better heard; some way of preventing sulphur from getting into mine water, and of cheaply purifying mine drainage; a practical stoker for burning bituminous coal in houses, without smoke; a safe method of burning powdered coal in houses; and many other problems of which any experienced mining man can think.—Howard N. Eavenson, Consulting Engineer, Pittsburgh, Pa., in a paper before the Second International Conference on Bituminous Coal, Pittsburgh, Pa., November 19–24, 1928.

Recent Developments in the Utilization of Bituminous Coal*

Important Points on Preparation, Processing for the Extracting of Liquid Fuels and Other By-Products, Utilization in Power Generation, Etc., Brought Out at the Second International Conference on Bituminous Coal in Pittsburgh

BACK of the Coal Conference in Pittsburgh at the Carnegie Institute of Technology, were three great factors of increasing urgency. In the first place, in two of the great industrial nations of the world, the United States and England, the coal industry is a sick industry. Conditions of overproduction are such that profits have reached or passed the vanishing point and, particularly in England, there is a steady condition of uncertain employment tending to pass into steady unemployment. It is believed that the only way out of this slough of despond is to find means to increase the demand for coal, which is possible only by discovering new ways in which it can be employed.

The second big factor is that such new ways of employment of coal as have been referred to above, have been and are being found every day. Only a few years ago practically the only by-product of commercial importance derived from coal was coal tar, which formed the basis of an important dye and special-chemicals industry. Today quite a varied list of substances are being produced from coal, such as gasoline, tar oil, ammonia compounds, methanol, and material equivalent to glucose, while the several hydrogenation processes promise to open entirely new fields for coal by-products, bringing them, for example, into competition with animal and vegetable fats in soap making.

The third and equally important consideration brought up in Pittsburgh by representatives of the great nations of the world, is the growing comprehension that under the present intense conditions of international competition it would be a very wasteful process to continue to burn coal in the primitive ways which were standard less than 20 years ago. Not only is coal an important asset of the nations fortunate enough to possess it and in consequence should not be wastefully destroyed, but low-cost power is becoming more and more one of the cardinal items contributing to national wealth, and it is wise, therefore, to pay the strictest attention to methods of producing it in the cheapest possible way. The Royal Commission on the British Coal Industry in 1925[1] reported the estimated reserves of coal in seams at minable depth at 197,000 million tons. Approximately 250 million tons are mined in Great Britain each year. Some of it is of the coking and semi-coking type, but about 147 million tons of the so-called free-retorting or non-coking coals are at present burned wastefully every year in the raw state. Of this 147 million tons, at least 80 million tons consumed annually for industrial and domestic purposes is of a character suitable for treatment in the simplest form of gravity-flow retort. Its consumption in a raw state is not only a direct economic loss to the community, but it causes an enormous indirect expense through generating smoke and is a serious menace to the health of urban populations. If treated, this coal would yield over 7 million tons of low-temperature oil per year, from which could be extracted a considerable portion of the liquid fuel at present imported into Great Britain from foreign sources. This matter of importation of liquid fuels from foreign sources is stressed not only by the British but by other nationals as well, as, for example, the Germans. The development of the motor car has created an insistent demand for liquid fuel, which is locally available only to a small extent in the European countries which have the most developed motor transportation. The matter of trade balances at the same time has since the war become particularly important to European countries, and the most vigorous effort is being made to find domestic substitutes for imported gasoline and Diesel oil.

The investment that would be required in England to treat the free-retorting coals is not great, and is said to be considerably less that £1 per ton of throughput. The semi-coke obtained from treating could be easily used in a pulverized form in power plants and as a substitute for anthracite in gas producers. It is said to make an excellent fuel for domestic purposes, and can easily find a good market, provided, as would appear to be the case, it can be sold at prices which are competitive with raw coal or gas coke.

Outside of India the British Empire contains vast deposits of coals that could produce liquid fuel by treatment, but very little oil except in Canada, which has enormous resources of oil-yielding materials in the bituminous sands of Alberta and the oil-shale deposits of New Brunswick. Neither of these materials, however, are as yet in a position to compete actively with natural gasoline.

Coal the King?

The place of coal in the national or world system of power generation formed a lively subject of discussion at the Conference. According to A. T. Stuart,[2] the day may come when solid fuels will largely disappear from the market and the demand will be almost exclusively for gases and readily gasifiable liquid fuels. Such fuels contain up to five times the amount of hydrogen contained in coal, and therefore, to produce the desired fuels without by-products and without loss, it will be necessary to decompose vast amounts of water in order to obtain the necessary hydrogen. This decomposition will release enormous amounts of oxygen. For the ideal process the only materials used, however, will be coal and water, all of which will appear in desirable products and none will appear as by-products or escape as flue gas. This ideal can be accomplished only by decomposing water in such a way that hydrogen and oxygen can be separated and directed into proper channels, where each will be used to the best advantage in the processing of coal and in the utilization of coal products.

Coal processing, in the opinion of the author, will center about water-power plants, the entire output of which in some cases will not be electricity but hydrogen and oxygen as already exemplified in the case of certain nitrogen projects, notably that of the 125,000-hp. plant of the Norwegian Hydroelectric Nitrogen Corporation.

* The second half of this review will appear in the February issue.

[1] R. H. Crozier, Manager, Mineral Oils Extraction, Ltd., London: "Low-Temperature Distillation—The British Coal Industry and Oil Supplies."

[2] A. T. Stuart, Consulting Engineer, Toronto, Canada: "Some Potential Relations Between the Electricity and Coal Utilization."

Mr. Stuart believes that already there are certain developments which indicate that solid fuels may gradually disappear from the market, and will be replaced by various fluid forms of fuel. Many homes are heated already by artificial gas and oil, and in Germany there is under way a project to supply cheap gas from the Ruhr district over great distances in competition with coal.

A great deal of activity is noted in the direction of reduction of ores to metal by means of gases instead of coke.

Mr. Stuart devotes considerable attention to the factors affecting the electrolysis of water and describes the future coal-processing plant as he sees it. He pictures the plant as located, for instance, on the St. Lawrence River with a water-power unit developing 100,000 hp. in direct-current power and feeding it directly into cells for the electrolysis of water, the production of which is to be six billion cubic feet of hydrogen and three billion cubic feet of oxygen per year. The hydrogen will be available for such purposes as reduction of ores, liquefaction of coal, etc., or may be used as a fuel. The oxygen will be used for the low-temperature carbonization and complete gasification of coal, and for other purposes. A variety of industries will center about water-power sites.

Coal and Water Power—Combustion Cycles

According to A. R. Smith[3] the kilowatt-hour has now become one of the major products of the United States. The yearly consumption is approaching one hundred billion kilowatt-hours, and if the present rate of increase continues, may reach in the early forties two hundred billion. This means that during the next twelve or fifteen years power plants must be built having an aggregate capacity equal to all that are now in existence, in addition to the very considerable number of new plants necessary to replace existing ones as they become obsolete, inadequate, and worn out.

For the past several years one-third of the electric energy consumed in the United States has been produced by hydraulic power, and two-thirds by steam power. This ratio has been so constant that it is believed no material change will occur during the next fifteen years. The hydroelectric plant has certain advantages, and even though more expensive developments may be delayed because of advances made by the steam plant, they will be ultimately undertaken. Among these advantages is the fact that the major portion of the investment is in structures which, if properly constructed, should last for ages. Most of the machinery is operated at low speed, low pressure, and low temperature, and has an exceedingly long life. The efficiency of converting potential water power into electric power is so high already that replacement for purposes of improvement in efficiency or increased output is unlikely. Because of this a hydraulic plant is entitled to a far lower depreciation than a steam-electric plant. In the development of the steam cycle, the steam pressure has been raised to a point where there is little more energy available, while the superheat has been raised to a point where special metals will have to be employed to permit any further increase in combination with the high pressure. In the regenerative, reheat cycle the heat available might be raised to something like 50 per cent, which with further improvements in apparatus efficiencies might permit reaching an operating efficiency in the neighborhood of 34 per cent, but to do this may mean an increase in the investment, with the result that the additional fixed charges may equal or exceed the gain made in fuel economy.

After briefly discussing the binary-vapor cycle, a new heat cycle is suggested which Mr. Smith calls the "combustion cycle," meaning thereby a cycle where fuel and oxygen are put together for the purpose of producing heat. The method which he suggests is to gasify the coal, completely extracting the tar oils from the light oils for sale and using the gas for the generation of power. Previous studies made of a combination steam-power and gas plant have failed to make a good showing because of the low thermal efficiency of the gas plant. Mr. Smith believes, however, that sufficient attention has not been given to the possibilities of more complete coordination of gas making and power production. What he believes is needed is essentially two-stage combustion. In the first stage the tar oils would be salvaged and the ash removed, which would be accomplished at low temperature. The second stage should be operated at high temperature for the production of steam at the highest efficiency with compact and simple equipment having but little thermal storage.

Regeneration on the combustion cycle has not been carried to its possible limits: first, because the stokers could not use extremely hot air, and second because the pulverizer, if using the same air for pulverization and combustion, would not perform properly due to the plasticity of the coal. Aside from the fuel-burning and preparation equipment, the furnace temperature became too high and tended to cause slagging of the ash or overheating of the boiler tubes.

If a clean gas is used as a fuel, if the furnace is completely water-jacketed, and if the boiler circulation is made more perfect, the furnace temperature can be raised very materially. With the tendency toward a higher furnace temperature, more heat can be transmitted in radiant form and more radiant-heat absorbing surface can be installed to replace convection heating surface. This might be accomplished by dividing the combustion chamber into smaller units, thereby getting more surface per cubic foot of combustion space. The whole idea would be to raise the average temperature difference between the steam-generating surface and the furnace and to remove the low-grade heat by returning it into the combustion air which is an all-low-pressure process.

To put more heat in the combustion air entails larger air preheaters, which have a limited life and, being made of metal, must be kept within the usual temperature limitations. It is possible, however, to substitute the recuperative preheater using gravel or refractory or cast iron, and carry the combustion-air temperature up to 1000 deg. fahr. Such apparatus would be bulky and heavy but crude, and could be located out of doors similarly to blast-furnace stoves. Such preheaters naturally would have large thermal storage; but thermal storage, external to the boiler and controllable such as this would be, is very desirable.

If the combustion air could be preheated to 1000 deg. fahr. and the products of combustion left the boiler at 1200 deg. fahr., the high-pressure steam boiler would be working at a much higher mean temperature differential than it does at the present time. Most of the heat could be removed in radiant form; there would be little thermal storage in the boiler uncontrolled, and an abundance of thermal storage external to the boiler under perfect control.

Raising the temperature of the heat cycle means raising the temperature of the combustion cycle. Water-cooled furnaces remove one objection to high combustion temperatures; the use of gas as a fuel would remove the other objection, namely, the slagging of the ash. However, the new scheme of drawing off the ash as liquid may be found suitable for such high furnace temperatures, provided suitable provision is made to prevent the slagging of the heating surface.

Such a high-temperature combustion cycle might be particu-

[3] A. R. Smith, Engineer, General Electric Company, Schenectady, New York: "The Kilowatt-hour and Thermal Economy of Its Production."

larly well adapted to the mercury cycle. The mercury boiler proper could reduce the temperature to 1200 deg. fahr. and the steam superheater might be used to protect some of the furnace walls, and the outfit would be simple and not unlike the usual steam boiler.

Gas-fired boilers could be located out of doors in almost any climate as they should require little attention and few repairs, and could be automatically controlled to perfection. With recuperative air preheaters of large capacity the boiler could be made in single large units, or could be subdivided into as many units as found desirable, as the investment would not be greatly increased thereby.

COAL PROCESSING

In the development of coal processing for the extraction of liquid fuels and other by-products, two tendencies have become apparent. One is to split the coal by the simple application of temperature in the presence of a regulated amount of air or steam. The other tendency is to treat the coal in the presence of hydrogen under conditions which will not only break up the coal into certain of its constituent parts, but in addition rebuild these parts by the addition of the hydrogen molecules so as to result in new synthetic products. This is made possible only by submitting the coal and hydrogen mixture to certain temperatures and pressures in the presence of materials that will favor or accelerate the combination between hydrogen and the coal derivatives, as this combination will not take place by mere contact between the two. This makes the matter of catalysis one of paramount importance in the treatment of coal, and the most important work which has been carried out along these lines in Germany has been based on certain new developments in this field.

An attempt to define catalysis and explain its mechanism was made at the conference by Dr. Carl Krauch.[4] According to his view, catalysis is essentially an electrical phenomenon. Matter, according to modern atomic physics, is built up of electrical particles kept together and linked within the molecule by the attraction and repulsion of these electric charges. It would further appear that the positive and negative electric charges contained in atoms do not unite in one and the same object, but are placed at a distance from one another. In consequence the particles, be they atoms or molecules, act in a bipolar way similar to a bar magnet. In an electric field they are subject to orienting forces, and if they are intermixed with atoms having a bipolar moment stronger than theirs an orientation takes place around these specially-strong-bipolar-moment particles. From this it is assumed that contact substances of a particularly strong electric bipolar nature are capable of effecting a specific deformation of molecules.

Another factor has now to be taken into consideration, and that is that catalysis is also a phenomenon of adsorption. If one molecule or atom has what might be called a "soft" spot, and a catalyst causes another molecule to deflect on to that particularly sensitive spot, a combination between the two molecules and atoms takes place which would be impossible or extremely slow otherwise. That the surfaces of solid substances may possess such spots of increased reactivity is generally known, and the significance of this phenomenon in the activity of heterogeneous catalysis has been previously pointed out by H. S. Taylor of Princeton University. The effect of catalysis in the conversion of hydrocarbons consists, however, not only in increasing the reactivity of the hydrocarbon molecules, but is also of importance in hydrogenation and dehydrogenation as well as oxidation in consequence of the peculiar activating effect of the contact substances on hydrogen, oxygen, water, and so on. Just how vast a field is opened by the catalytic conversions of hydrocarbons may be seen from the results achieved by the laboratories of the I.G. as told by Dr. Krauch (and Dr. Krauch naturally did not probably tell quite everything). "I.G.," it may be mentioned, is an abbreviation of two German words meaning "community of interest," and refers to a combination of some six of the most powerful concerns in the German dye and chemical industry.

In Germany a big industry is already being built up based on catalytic conversions of hydrocarbons, particularly those in the presence of oxygen and steam. The conversion of methane is of especial interest as large quantities are obtainable from coke-furnace gas and natural gas. Its suitability for the production of hydrogen makes it one of the most important basic materials of modern chemical industry. Hydrogen may be obtained from it either by the direct splitting of methane into its elements or by several processes involving oxidation with oxygen and steam. Moreover the splitting of methane may be so controlled that instead of complete decomposition into the elements, a formation of acetylene takes place. Also methane can be oxidized so as to obtain either methanol or formaldehyde. Whether these latter processes are of economical importance remains to be seen, particularly as methanol can be synthesized from carbon monoxide and hydrogen.

The oxidation of hydrocarbons of the paraffin series led to rather an unexpected development, as the I.G. chemists succeeded in producing from paraffin fatty acids suitable for the manufacture of soap.

Chemically, however, the most important application of the catalytic hydrogenation of hydrocarbons lies in the production of liquid fuels. This was difficult at first because the catalysts previously used were destroyed by poisons such as sulphur and oxygen contained in the oil or coal. Recently, however, a new catalyst has been found, which is but little susceptible to sulphur and other contact poisons. Moreover this new class of catalysts permits a control of reactions to an extent not previously available. This in its turn permits not only increasing the output of the liquid fuels but improving the quality obtained. Incidentally a material has been developed which acts as a negative catalyst and reduces the tendency of the fuel to "knock." Various kinds of coal have been tried by the Leuna works. At present the annual production is 70,000 tons of gasoline, of which 40,000 tons are obtained from coal. It is hoped that at the end of next year the production will be raised to 250,000 tons. The gasoline produced appears to equal in all essential properties a good gasoline obtained from crude oil in the ordinary way, and the close resemblance of synthetic gasoline and other products obtained by the hydrogenation of coal in their natural counterparts throws a light on the origin of crude oil.

The use of catalytic processes for treating coal-tar crudes is not limited to Germany, and a considerable amount of work is being carried on in the United States.[5] The problem which had to be solved here was that of producing anthracene from coal tar in large quantities and free from impurities, of which carbazol and phenanthrene are the most important. The problem was a difficult one, and the processes previously available were quite dangerous inasmuch as crude anthracene contains a considerable number of compounds which are very irritating to the skin and may even cause cancer.

In the new process crude anthracene is vaporized and mixed with air. The mixture is then passed over a suitable catalyst

[4] Dr. Carl Krauch, Director, I.G. Farbenindustrie A.G., Ludwigshafen am Rheim: "Catalysis Applied to the Conversion of Hydrocarbons."

[5] Alphons O. Jaeger, Technical Director of the Selden Company, Pittsburgh, Pa.: "New Catalytic Process for the Utilization of Coal-Tar Crudes."

which does not attack to any considerable extent the anthracene but favors total combustion of most of the impurities, including carbazol and other nitrogen compounds. The product resulting from such a catalytic purification is a high-grade anthracene containing phenanthrene as almost the only impurity. This can now be removed in several ways. The process is applicable to semi-crudes as well, and may be applied to semi-purified anthracene as a starting material. In the course of this investigation, it was found that the most effective catalysts are the so-called stabilized ones, particularly those which contain compounds of the alkaline metals and some earth metals. This is in line with German experience. The manner in which the catalytic active components are associated with the other components in the mass may affect the action of the mass very considerably. A number of experiments have been made and were described to the conference to show the manner of carrying out the selected catalytic purification processes.

It is interesting to note that the same problem of purification of anthracene led to the development of a process of purifying by solution, the advantage of this process being the ability to recover carbazol as a by-product. It so happens that it may be quite an important material for making dyes. Furfural, which is relatively cheap and has recently become available in enormous quantities through production from corn stalks, etc., may be used as a solvent. The new solvent purification and the new purification by selective catalytic oxidation are in a sense rival processes; they may, however, be combined, and in such an event will give yields and a quality of product that leave nothing to be desired.

Economics of Catalysis. A general survey of the situation in catalysis as applied to coal treatment was given by F. Zur Nedden.[6] This author considers the amount of capital which has to be invested in coal treatment and the compensating returns. He comes to the conclusion that the higher the quality of the bearer of energy into which coal is transformed, the greater is the amount of capital which must be invested per ton of annual throughput. The processes for improving coal by enhancing the value of the energy contained therein were built up on coal, notwithstanding the fact that such improved form of energy is often offered by nature ready made. Thus manufactured gas may compete with natural gas, and electrical energy generated from coal with energy from water power. Because of this Mr. Zur Nedden believes that the processes of chemically adding hydrogen to the natural hydrocarbons as contained in coal and petroleum will prove attractive to the American business man, in spite of the fact that he is wading in natural oil.

More About Methane. Pure methane alone when subjected to the action of heat yields carbon and hydrogen.[7] In the presence of catalyzers such as nickel, cobalt, and iron the equilibrium point is more quickly reached. Previous investigators have found that under certain conditions methane instead of decomposing into carbon and hydrogen alone may form hydrocarbons. Dr. Fischer investigated this situation very completely and found that methane can be converted into benzene and other benzene hydrocarbons, if it is heated to temperatures of 1000 to 1200 deg. cent., provided the period of heating is kept shorter than ten seconds. Under these conditions the process can be carried out under ordinary pressure, and catalyzers are not needed. On the other hand, conditions can be so controlled that the chief reaction product consists of benzene hydrocarbons, more than half of which is benzene. The amount of the unsaturated hydrocarbons in the residual gas can be reduced to 4 per cent, and the separation of carbon can be almost completely prevented.

Dr. Fischer reviews various patents, most of which have been granted within the last three years, and comes to the conclusion that from the claims of these patents one might be led to believe that for the production of benzene hydrocarbons in larger yields than are known at present in scientific literature, the use of pressure and of catalyzers is necessary. He believes, however, that neither of them is necessary and states it is not yet known whether any of the more complicated patented processes will give better yields than can be obtained with ordinary pressures in a single process.

Natural Catalyzers. In the usual catalytic processes where catalyzers are used they are introduced externally,[8] and Donovan J. Salley and Dr. A. W. Gauger have investigated another angle of the problem, namely, the influence of inorganic materials on lignite carbonization. The conclusions at which they arrived are as follows:

1 Inorganic materials may exert a specific effect on the structure of the char as well as the yield of char, tar, and gas from the carbonization of Velva lignite. It seems essential that one be cautious in predicting the effect of ash material from results of experiments of this nature without being certain that the added material is chemically identical with the inherent mineral matter in the coal in question.

2 Hydrates of aluminum chloride, sulphate, and nitrate, magnesium sulphate and chloride, and strontium chloride alter the structure of the char produced, yielding a hard pseudo-coke differing materially from the soft powdered char of the untreated coal, whereas the anhydrous salts produce soft, fine chars.

3 Ferric chloride hydrate increases the yield of char at the expense of the tar.

4 Sodium carbonate decreases char and tar yields and increases gas yields.

5 Silica is without effect.

6 A mechanism for the formation of pseudo-coke is suggested.

The C.T.G. Process. This process is operated in Germany by the Chemical-Technical Company and its purpose is to convert slack coal and fines into lumpy smokeless fuel.[9] The characteristic feature of this process is the employment of a circular cell oven described and illustrated in the original paper. The internal structure of this oven has a series of horizontal angular heating chambers placed one above another, firmly screwed together, and separated by coking chambers. The shell is made to revolve at a predetermined rate. The coal is fed into the chambers under pressure but remains at rest during the period of carbonization. In the oven the coal is partly gasified and partly converted into coke. The large furnace in operation at the Rhine Steel Works carbonizes fines, the largest size of which is 1 mm. (0.04 in.). The low-temperature coke produced contains from 8 to 10 per cent of volatile matter and burns with a considerable volume of flame which is quite smokeless. It therefore makes a good substitute for anthracite coal, and is suitable for domestic fuel.

The Carbocite Process. This process was developed by the American Gas and Electric Company[10] who had in mind its

[6] F. Zur Nedden, Secretary Fuel Committee of the Federal Coal Bureau, Berlin: "Carbon, Hydrogen, and Capital."

[7] Franz Fischer, Kaiser Wilhelm Institut for the Study of Coal in Mulheim-Ruhr: "The Formation of Benzol and Other Hydrocarbons by the Action of Heat on Methane."

[8] A. W. Gauger and Donovan J. Salley, University of North Dakota: "The Influence of Inorganic Materials in Lignite Carbonization."

[9] Josef Plassmann, Director, Chemische-Technische Gesellschaft, Duisburg, Germany: "Conversion of Slack Coal and Fines Into Lumpy Smokeless Fuel—Low-Temperature Coke—by the C.T.G. Process."

[10] W. H. Allen, Jr., Chemical Engineer, American Gas and Electric Company, New York: "Low-Temperature Distillation of Coal by the Carbocite Process."

possible economic value in connection with central power-generating plants.

The purpose was to develop a smokeless fuel for domestic and power-plant uses, which would not require the complications involved in briquetting. The process consists essentially in the continuous treatment of coal in horizontal or slightly inclined rotary furnaces. Crushed coal is treated first in a rotary furnace where it is crudely dried and then reheated to some 450 deg. fahr. in the presence of a regulated amount of hot air passing in a direction to that of the coal.

From this furnace the coal flows through a coal seal to another rotary where the temperature is raised to 900 or 950 deg. fahr., as the distillation and coking take place. At all times the charge is flowing and mixing continuously, and the hottest material leaves the rotary shell at the crest of the pile and rolls to the base of the pile in small detached pieces. This action causes the ball formation, and the heating proceeds very rapidly until the plastic stage is reached. The distillation is carried on until the volatile matter is reduced to about 12 to 14 per cent, giving a tough and dense coke. Practically all of the coke is finally discharged in spheroidal form, the pieces ranging in diameter from $^1/_4$ in. to 4 in. or larger.

The tar produced by this process shows a minimum of cracking action, though the gas, averaging about 800 B.t.u. in the unwashed state, is low in quantity. The chief difficulties encountered have been of a mechanical nature due to the necessity of operating moving machinery continuously at temperatures approaching dull red, introducing a fusible material and extracting solid residue, and at the same time minimizing gas leakage from all of the joints and cells. The installation is still considered to be an experimental undertaking, although the product is being sold.[10]

The Trumble Low-Temperature-Carbonization Process. In this process[11] the raw material passes from storage bins into thermostatically controlled preheating chambers where the raw material is preheated and dehydrated by utilizing products of combustion from the boilers and preheaters. From the preheaters the material is fed intermittently into the distilling apparatus. The process is carried on by means of a supply of hydrogenated steam passing from retort to retort. The end products from bituminous coal consist of gasolines, naphtha, benzol, fixed gases, creosotes, ammonia, etc., coke being the solid residue. Hitherto only experimental and semi-commercial plants have been built, among them a plant at Yokohama, Japan.

Briquetting. The question of binder in the manufacture of briquets is of well-recognized importance. In South Africa a pulp binder has been developed and it is expected that commercial manufacture will start next year in Spain.[12] The raw material for the binder, consisting of grass, straw, bagasse, or other non-lignitic vegetation, is laid on hard ground in stacks. Each layer of about six inches in thickness is first wetted and then sprinkled with dry chemical preparations. A second layer is then laid down and wetted and sprinkled, and the stacking is continued until the entire heap is about 12 ft. high. The material shows a heat reaction through fermentation. Usually two to four months are required for this fermentation, after which it is masticated and then ready for use. The mixture of coal and binder may be pressed either hot or cold.

The "Cifep" Process.[13] Henri Lafond examined the possibility of treating hydrocarbons by subjecting them to the action of heat, under atmospheric pressure; and the experiments made along those lines showed that, under such conditions, low-boiling-point hydrocarbons were indeed obtained, the content of which in saturated products was comparatively low. But such results could be obtained only by submitting to the double condition, which consists in adopting higher temperatures and in sustaining important losses both in coke and gas. Two main advantages resulting from the adoption of the pressure treatment which should be noted are the reduction of the dissociation temperature of the hydrocarbons and the lowering of the losses due to the formation of gas and coke.

Under these conditions, the "Cifep" process was developed for the treatment of hydrocarbons at normal pressure by resorting to suitable catalyzers likely to fulfil the double effect hitherto obtained under high pressures.

Solid fuels capable of producing primary tars by distillation are treated in a low-temperature distilling furnace (500 deg. cent. maximum) so that the vapors of tar thus produced will not be cracked inside the furnace.

The vapors of tar are thence conveyed to a nest of tubes containing the catalyzers, the latter being maintained in a drying plant heated to a temperature varying according to the products to be treated, but remaining in the neighborhood of 380 to 400 deg. cent.

The numerous tests made have shown that a rather considerable number of metallic oxides or oxide mixtures were apt to provoke the dissociation of hydrocarbons under these conditions, yielding low-boiling-point products without generating either gas or coke in great quantities.

But distillation products and particularly brown coals very often have a high sulphur content. The gases produced in the course of the distillation are then charged with quantities of sulphureted hydrogen, sometimes as high as 15 per cent of the volume produced, and the passage of the gases at a temperature of 400 deg. over the catalyzers naturally converts the oxides into sulphides.

But, at the same time that the sulphur settles on the catalyzing medium, an inverse reaction takes place, viz.: the reduction of the metallic sulphides by means of the hydrogen of the gas, the content of which varies between 20 and 40 per cent, according to the fuels subjected to the treatment.

In order to get the maximum effects from this reaction, which is capable of continuously renovating the metal, the catalyzers to be selected should, as far as possible, be metals with which the formation of sulphide in the presence of sulphureted hydrogen and of hydrogen is reversible at the working temperature, and the tension of the sulphureted hydrogen in the gaseous stage should be reduced to a minimum.

The same process is applied to the treatment of the residues of crude oil. Obviously, the distillation furnace, in this case, is eliminated and replaced by an appropriate apparatus causing a preliminary vaporizing. In this apparatus, the product to be treated is introduced in a continuous manner and heated to approximately 400 deg. cent. At the same time as the oil residue, a certain quantity of water is introduced, varying between 5 and 15 per cent of the volume of oil treated, according to the quality of the oil.

The mixture of the oil and water vapors is thence conveyed to a series of successive purifiers and catalyzers.

The catalyzers used in the treatment of the low-temperature-distillation tar vapors, although they keep a constant activity under the very effect of the reactions, have not given interesting results when applied to crude oils; there is, however, a formation of light products, but causing in some cases as much as 25 per cent losses.

[11] Col. J. W. E. Taylor, San Francisco, Calif.: "Trumble Low-Temperature-Carbonization Process."

[12] C. J. Goodwin, Consulting Engineer, London, and J. N. White, Consulting Technical Chemist, London: "Notes on the Use of Smokeless Pulp Binders for Briquetting."

[13] Henri Lafond, Gen. Mgr. Compagnie Internationale pour la Fabrication des Essences et Petroles, Paris: "A Process for the Catalytic Treatment of Hydrocarbons."

Reflections on the Fundamental Principles of Mechanics as Applied to Human Activity

By F. W. ROYS,[1] WORCESTER, MASS.

AS FAR as we know, the laws of motion as arrived at by Sir Isaac Newton form the most convenient and satisfactory basis for the study of dynamics. In the study of theoretical mechanics a clear understanding of these conceptions is very necessary before any mastery of the subject is possible. In these reflections it is the author's purpose to show that essentially the same principles are just as rigidly related when applied to human activity as they are in the case of engineering mechanics.

Newton's first law of motion states that every body continues in a state of rest or uniform motion in a straight line except in so far as it is compelled by the action of an external force to change that state.

Newton's second law, restated from a little different point of view, is that force is proportional to rate of change of momentum. Or, to state it in still another form, force is proportional to the product of mass multiplied by acceleration.

Now suppose that for the purpose of this philosophy we substitute the word "effort" for force, and for the word "mass" we substitute the phrase "magnitude of project," or simply "project." Also for the word "velocity" we substitute "speed of accomplishment along a certain definite line."

Newton's second law expressed in terms of these conceptions would appear in the following form: Net *effort* varies as (Magnitude of *project*) multiplied by (*Rate of change* of *speed* or *line* of *accomplishment*).

Examination of this statement clearly shows that the greater the magnitude of the project, the more effort will be required to get it under way, but it shows much more than that. First it shows that it is *net* effort that is the important thing. Any favorable effort is sure to start some unfavorable effort or opposition on the part of some one, or some obstacle or resistance is sure to arise. It is only when the favorable or positive effort exceeds the unfavorable effort, or resistance, that progress will begin.

Now so long as we are able to keep our effort in excess of the resistance, our *speed of accomplishment* will increase; but it always happens that as the speed of accomplishment increases, the resistance increases also, and soon a constant rate of accomplishment along a definite line is attained at the expense of effort maintained to overcome the increased resistance.

It generally happens that continuing along one line of accomplishment is not at all satisfactory and the line of progress must be shifted. The statement of the principle of Newton's law shows that new effort in a new direction must be exerted simply to change the line of progress, even though the rate may remain the same. This effort must be maintained during the entire time of the shift, and the time necessary to make the shift is dependent upon the net effort available for such a shift. Some individuals once started on one line of accomplishment are not able to muster enough effort in a new direction to overcome the resistance to the change. These are the "single trackers." Other individuals are not able to direct their effort very well. The result is that what effort they exert is used up in changing from one line to another, with little progress anywhere. These are the fellows who are always "starting something" but seldom really accomplish very much.

A few individuals are able to direct their effort—and a great deal of it—to accomplish as much as may be desired along any given line, and then redirect the effort to change the line of accomplishment when the proper time comes. These individuals are the far-seeing, clear-thinking executives who handle the project and carry it to completion in all its parts, one as well as another.

We often hear the remark, "Oh, that will take care of itself now that we have got it going." To the engineer or scientist that statement will at once suggest *kinetic energy*, or the capacity for doing work by virtue of velocity combined with the size of the moving thing. Here the statement is referring to the tendency of a project to "keep going" because it is already going forward well and rapidly. It is necessary to realize, however, that the project which keeps going when left without the push of executive effort has to overcome by its own inertia the adverse influences which are at work always and forever, and it does so at the expense of the speed of advance. If left too long it will stop altogether. If it is ever to start again new effort must be expended to get it under way again. The new effort is always a waste of time and money which might have been usefully used elsewhere. Many a man has gone bankrupt because he has refused to recognize the inexorable workings of this principle.

It sometimes happens that a small problem or project has very many sides, and that all sides must be developed at once. Here it is quite necessary to use effort to change the line of attack as often as need be. Some individuals are so constituted that they become absorbed in one phase and lead themselves entirely away from the main project, which they finally lose track of completely. These are the ones of whom it is often said that they are "flying off on a tangent."

It may be of interest to consider *work* from the standpoint of this philosophy. In mechanics work is defined as the product of a force multiplied by the distance through which it acts. Here it might well be defined as progress against resistance. Progress against resistance is only possible by the expenditure of effort. If we cannot muster enough effort to overcome resistance then there is no progress, and what we are apt to call work is nothing but misdirected "fuss and feathers" used up in *unproductive effort because there is no progress*. Careful consideration and ensuing of the resistance to be encountered and careful direction of effort might result in enough net effort in the direction to overcome the resistance, in which case progress *must* be made and useful work accomplished. Just a little more effort many times would spell the difference between utter defeat and satisfactory accomplishment.

In these days of hustle and bustle the watchword seems to be "power," and this discussion would hardly be complete without some reflection thereupon. Power is defined as the rate of doing work, so whom may we rightly define as a powerful man? There seems to be only one real answer, namely, that he is the one who can accomplish a great deal in a short time and keep it up for a long time—and what does this involve but the appreciation of all of the foregoing reflections? The individual who has the will to exert great effort, the brain to direct it where it will be the most effective, the push to follow it up and make progress, and the vitality to keep at it for a long period of time, is the powerful man and the man who can sit on top of the world.

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SURVEY OF ENGINEERING PROGRESS

A Review of Attainment in Mechanical Engineering and Related Fields

The Precompression-Chamber Diesel Engine

WHEREAS there have been many investigations of air-injection and solid-injection types of Diesel engines, the precompression-chamber type has been more or less neglected. From this point of view the present investigation is of particular interest. This was carried out on a stationary single-cylinder horizontal-type four-stroke-cycle unit rated at 18 hp., built by the Körting Brothers Company in Hanover. The engine has the following dimensions: Stroke, 316 mm. (12.44 in.); bore, 190 mm. (7.48 in.); speed, 350 r.p.m.

This particular engine works on a cycle somewhat different from that of other precompression-chamber engines. The passage between the chamber and cylinder is of small diameter, which causes a considerable fall of pressure during the compression and produces a high velocity of flow of air in the chamber. The fuel is injected into this passage shortly before the piston reaches the dead point. The injection being in the form of a closed jet, it is carried out in such manner that the fuel strikes the cold wall of the passage and loses a good deal of its kinetic energy.

This produces a great increase in pressure in the chamber, followed by a reversal of the flow of air. As a result the chamber is blown clear and the main combustion takes place under the influence of the flow energy (turbulence) produced by the blowing out of the chamber in combination with further injection of fuel through the nozzle into the cylinder only.

In the conversion of the chemical energy of the fuel into heat and useful work which takes place in all motor processes, the question of time is of the greatest significance as far as making ready for and carrying out the combustion are concerned. In the classical Diesel engine the injection air acts as a carrier of energy, and in this way sufficient atomization and combustion of the injected fuel is obtained. In the process used in the engine under consideration the flow generated by injection air of the "compressor-Diesel" engine is replaced by a combination of flow effects having their origin not in external influence, but in the interplay between the cylinder and precompression chamber (hereinafter referred to simply as chamber). Because of this the investigation of the working cycle of the engine must include an analysis of the interflow between the cylinder and chamber at full load; in this the revolutions per minute appear as a variable parameter, while the influence of combustion is practically entirely eliminated.

Various Kinds of Flow of Air and Mixture in the Cylinder and Chamber

Because of the comparatively low pump pressure the energy required to inject the liquid fuel in the precompression-chamber-type engine is slight, and because of this the flow into and out of the chamber becomes of particular importance. As the injection of the fuel takes place before the piston reaches the dead point, it is mainly the kinds of flow occurring during the compression that need to be considered.

The author gives an extensive mathematical analysis of the various kinds of flow, from which it follows that in the first place the pressure in the cylinder increases during the compression period more rapidly than in the chamber, the result of which is that there is a vigorous flow of air from the cylinder into the connecting passage and this flow penetrates far into the chamber. The variation of pressure in the cylinder and the chamber depends on the throttling effect of the passage and the piston speed or revolutions of the engine. If the revolutions are very low the pressures in the cylinder and piston become instantaneously equalized, with the result that the final compression pressure is determined by the compression ratio. If, however, the revolutions are high, then the final compression pressure is determined only by the ratio between the compression volumes in the cylinder and chamber as the air compressed in the cylinder has no time to flow over into the chamber. Curves in the original article illustrate the pressure variations with time during compression.

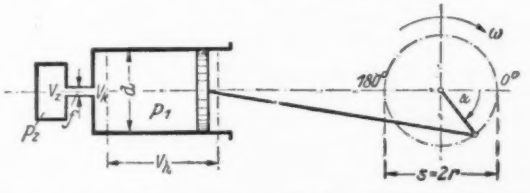


FIG. 1 SCHEME OF PRECOMPRESSION-CHAMBER DIESEL ENGINE
(V_z and V_k are respectively the volumes of the precompression chamber and the clearance space in the cylinder; f is the connecting passage.)

When the revolutions are neither zero nor infinity, but lie within practical limits, the pressure in the cylinder is higher than that in the chamber; hence there is a flow of air from the former into the latter, producing turbulence in the chamber. As a measure of the turbulence may be taken the flow energy produced, which depends on the weight of the air transferred and next on the instantaneous air velocity. The author gives mathematical expressions for all of these relations. He considers the time functional variation of the energy flow or turbulence in the chamber during compression, as it is desirable that it should reach its maximum during injection shortly before the piston reaches the dead center.

The relations governing the flow and hence the conditions affecting ignition and precompression of the fuel vary with the change of the r.p.m. of the engine, all other conditions being equal. An investigation of the operation of the engine at three different speeds of rotation has given a group of curves shown in the original article. Already at the nominal speed of 350 r.p.m. the theoretical maximum of air flow during compression has been exceeded, the turbulence in the chamber during injection at the same time being at a maximum. As the speeds decrease, the amount of air forced over from the cylinder into the chamber increases moderately, while the turbulence decreases very rapidly.

The difference in pressure between the cylinder and chamber and the velocity of flow from one to the other increase with increasing r.p.m. The energy of flow during the entire compression stroke attains finally the same value that is obtained in the classical Diesel process by the high-pressure injection air, but the

amount of turbulence in the chamber, because of its smaller size, is greater than that in the combustion space of the air-injection Diesel engine. Since there is enough air present in the chamber and the temperature obtaining therein is high, all the conditions are satisfied which with proper injection of the fuel will produce a rapid and certain ignition; the precombustion in the chamber is developed and an effective mean combustion in the cylinder becomes available in each working stroke.

The author then proceeds to give a detailed numerical computation of the entire working cycle at full load. While this part of the article is very interesting, it is necessary to omit it here because of lack of space. He then goes on to investigate what happens in the chamber and cylinder. This part is largely mathematical and only the author's general conclusions can be reported here. As far as combustion in the chamber is concerned, he says, it is largely governed by the combustion of the fuel present in the chamber at the instant of ignition. On the increase of pressure produced in the chamber by combustion, then, depends the injection process into and the course of combustion in the main cylinder. The author shows that the temperature in the cylinder at the beginning of the compression stroke is 366 deg. cent. abs. The turbulence in the chamber varies during the compression stroke and is dependent on the crank angle. Hence the weight of the air contained in the chamber is constant for each crank angle. On the other hand, the amount of fuel present in the chamber at each instant depends on the injection law, the injection velocity being determined by the difference in pressure between the pump and cylinder and the coefficient of efflux from the nozzle. The author finds that the average velocity of injection is 158 m. per sec. (518 ft. per sec.), from which he derives a value for the coefficient of efflux of the fuel from the fuel nozzle. He finds further that the combustion in the chamber takes place with a considerable excess of air, which he proves by an analysis of gases taken from the chamber. He confirms this by showing that in the gases taken from the chamber there were no indications of incomplete combustion of either hydrogen or carbon monoxide, and points out that the process of combustion in the chamber as a function of time may be completely investigated by taking samples at various crank angles. This method of analysis shows that an increase of pressure occurs in the chamber only once, as has been already established by the indicator diagram. While the combustion is complete, it does not reach its maximum value which corresponds to the largest possible content of carbon dioxide in the exhaust gases. A separation of carbon takes place during the combustion. As there is a reversal of flow between the cylinder and chamber at the instant of ignition because of the rise of pressure taking place in the chamber, no more air can be supplied to the chamber from the cylinder. Therefore the combustion which occurs in the chamber during that time interval takes place only with the amounts of fuel and air present therein (i.e., without any outside supply of air from the cylinder). This permits computing the time curve of combustion in the chamber as a function of the known combustion of gas and air, a problem which the author works out.

An essential characteristic of the working cycle of a precompression-type Diesel engine is that the amount of fuel injected into it is separated into two parts as a result of ignition in the chamber. The first part is burned with a considerable excess of air (46 per cent) in the chamber and creates a very clearly defined preliminary explosion, which in its turn produces a powerful atomization of the remainder of the fuel in the cylinder. The atomization of the first part of the fuel occurs under the influence of the high-velocity stream of air flowing through the passage connecting the chamber and the cylinder, and is due to the backward flow from the latter into the former. The high temperature prevailing in the chamber and the extremely powerful turbulence therein contribute greatly to the ignition of the fuel. The fear of earlier designers that coke deposits in the chamber and nozzle would interfere with the operation of the engine are effectively counteracted by the fact that combustion in the chamber takes place in the presence of a large excess of air. Further, since because of the high velocity there is a very fine atomization of the fuel in the chamber, there is every evidence to the effect that a very rapid oxidation of the fuel takes place, followed by a rapid break-up of oxygen compounds. Immediate ignition of the fuel following upon its exit from the nozzle is prevented through the fact that because of the flat shape of the chamber, the path from the nozzle to the opening of the connecting passage between the chamber and the cylinder is very short, and the fuel is injected into the passage as a closed jet. So little time is available and the surface of contact during the passage of the fuel jet through the chamber is so small that neither ignition nor any alteration of the liquid fuel jet can take place. To illustrate this it may be stated that in the machine under test the length of the path was 11 mm. (0.433 in.) while the velocity of the fuel jet was 158 m. per sec. (518 ft. per sec.), with the result that the time of passage of the jet through the chamber was of the order of 7×10^{-5} sec., or about 100 times less than is necessary to effect ignition of atomized liquid fuel.

Another important characteristic of this process is the use of a water-cooled passage between cylinder and chamber and a powerfully cooled chamber. Actual temperature measurements made in connection with the tests here referred to show that the inner-wall temperatures are very low and that at no time do they exceed the wall temperatures of water-cooled explosion-type engines. There is no question but that these low wall temperatures materially affect the ignition in both the connecting passage and the chamber itself. It is noted in this connection that the influence of heat losses in cooling the chamber is as a rule greatly exaggerated, and the author shows from his heat balance that only 3.6 per cent of the heat content in the fuel is lost in this way, while 38.8 per cent is abstracted by the cooling water.

The fact that combustion in the chamber takes place with an excess of air is considered to be new. The elimination of the products of combustion from the chamber takes place by the interchange between the chamber and the cylinder. Furthermore the exhaust and suction strokes of the engine piston exert a suction action on the chamber gases, so that the weight of any residue that may remain in the chamber is very small (on account of the high temperature of the gases). All of these factors contribute to the facts that the charging of chamber with fresh air in each cycle takes place regularly and that a uniform mixture ratio of fuel and air is regularly maintained. Of course, the process of combustion in the chamber in order to be complete requires a certain amount of time, but this time period does not exceed, as is shown by the present tests, about 0.045 sec. Notwithstanding complete combustion in the chamber as shown by the absence in the chamber gases of hydrogen and carbon monoxide, the carbon dioxide content was lower than its possible maximum. This would indicate that the time available for combustion is not sufficient in order to burn without residue all the carbon compounds of the gas oil, a material not at all uniform chemically. Measurements of the combustion process would indicate, however, that the combustion is not at an end when ignition and the first rise of pressure take place. The carbon compounds of lower oxidation velocity needs a longer time for their decomposition and for the complete conversion into carbon dioxide and water vapor, hence after-burning takes place. The author assumes that combustion occurs under such conditions that separation of carbon takes place. For the process of combustion this circumstance is not at all unfavorable, as glowing minute particles of carbon act as excellent catalyzers and powerfully con-

tribute toward carrying over the process of combustion from the chamber into the cylinder.

In other kinds of precompression-type engines the first part of the fuel charge is consumed under conditions of considerable air deficiency; this causes an incomplete pressure rise in the chamber, and there is a tendency to heat to a considerable extent the main part of the charge while it is traveling in the form of a jet through the chamber. As this heating occurs under conditions of oxygen deficiency, a break-up of the fuel is apt to occur. In the engine here described the first part of the fuel charge enters the chamber under conditions of the greatest possible turbulence, and comes immediately in contact with an excess of oxygen. This makes it possible to control the preexplosion in the chamber both from the point of view of time and from that of the mechanism of combustion. Furthermore the use of high-velocity air in the chamber for the atomization of the injected fuel permits operating with a low pump pressure because the atomization of the fuel is produced not by the pump pressure as in other engines, but by the turbulence in the chamber itself. The combustion gases ejected from the chamber still contain a considerable amount of free oxygen, which comes in quite handy in maintaining the main combustion of the fuel and in helping in the consumption of the second part of the fuel injected. This latter takes place within a very short time, but after a thorough preparation of the individual fuel molecules. Since the ignition conditions in the chamber are usually so good, the engine can burn rapidly and reliably heavy oils having a high ignition point, and without any mechanical alterations.

As a measure of the degree of turbulence may be taken the flow energy of the air jet in the chamber. The author shows that this energy is equal to 0.46 m-kg. per effective horsepower, and for the sake of comparison states further that in a 50-hp. air-injection engine its energy is only 0.30 m-kg. per hp.

The amount of ejection energy of the chamber exhaust gases is determined by a proper selection of the "injection ratio," which means the proper ratio between the amount of fuel injected into the chamber and that injected in the cylinder. The author discusses also the time element as affecting the process of ejection of the exhaust gases from the chamber. The time sequence of the phases of combustion in so far as the chamber is affected is given in the original article. He comes to the conclusion that the fuel injected into the connecting passage between the cylinder and the chamber must be thrown back into the chamber before the conditions permitting ignition are established. To do this a crank travel through an angle of 8 deg. is necessary, or a period of 3.84×10^{-3} sec. The author cannot as yet give the details of the main combustion process in the cylinder. He believes, however, that it is certain that complete preparation of the fuels up to the point of combustion does not take place during its travel through the chamber and the connecting passage, as both the time and the length of the path are far too short. The lag of combustion as compared with the injection of fuel shows clearly that the transformation of the liquid fuel takes place in the cylinder itself. From the point of view of time the main combustion in the cylinder in the precompression-type engine does not differ from that in the air-injection engine. The velocity of combustion can be computed by differentiation from the time curve of combustion in the cylinder.

The loss of heat to the cooling water in small precompression-type engines is larger than in air-injection engines of the same size. This does not imply an inferiority in economic efficiency as a greater loss to the cooling water means a smaller one to the exhaust gases, as the author shows by actual figures. In the case of the engine on which the tests were made, he found that the cooling losses of the chamber were 8.6 per cent, of the connecting passage, 5.7 per cent, and of the cylinder, 85.7 per cent.

The effect of "turbulence velocity" of the combustible fuel on the heat transmission to the walls of the combustion chamber is more marked in small combustion chambers such as those of engines of small output than in large ones. The author established this by tests on two engines. He found, however, that on the average, in the case of the engines tested, the heat lost to the cooling water was approximately equal to that lost by way of exhaust gases, which is the same as is the case of air-injection engines of the same output. With an efficiency of 36 per cent it would appear that even for larger-cylinder performances the precompression process is equal to the injection process.

While in the single-cylinder 18-hp. engine used in the laboratory tests the loss to the cooling water amounted to 42.4 per cent, in the case of a 150-hp. engine it was only 28.3 per cent. The surface-volume ratio of the combustion chamber in these engines was 44.8, and the author shows that if the losses to cooling water are assumed to be directly proportional to this ratio and to time, which means inversely proportional to the r.p.m., then approximately the same figure is obtained as determined by actual tests. It would appear, therefore, that the higher heat consumption per horsepower-hour of the laboratory engine is due not to greater loss to cooling water but to the comparatively long period of injection. By using a different fuel-pump cam, the specific consumption may be brought down to what it should be for a precompression-type engine. The author believes that the precompression process should be particularly suitable for the high-speed Diesel engine, because a rapid heat transfer to the injected fuel together with excellent atomization can be obtained by very simple means because of availability of high temperature and active turbulence. The sooner ignition follows upon the gas formation through the break-up of the molecule, the better combustion takes place and the smaller are the heat losses.

The development of the precompression engine to its present form took a long time, and in fact goes back to the work of Diesel himself. The author does not consider that the peak of the development has been reached as yet. As often happens, in this case practice has run ahead of a clear comprehension of the scientific background, and the author is particularly hopeful that the development of this type of engine will permit utilization therein of German fuels.

As far as the combustion of heavy oils with a high ignition point and large content of carbon is concerned, the precompression type is superior to the air-injection machine, and the author considers its reliability even under difficult conditions of operation as established beyond question. (Paper by Prof. Dr. of Engrg. Kurt Neumann of Hanover, before the Institute for the Study of Internal-Combustion Engines and Technical Thermodynamics of the Technical High School in Hanover. *Zeitschrift des Vereines deutscher Ingenieure*, vol. 72, no. 36, Sept. 8, 1928, pp. 1241–1248, 10 figs., *tmA*)

Short Abstracts of the Month

AERONAUTICS (See also Internal-Combustion Engineering: Packard Aircraft Diesel Engine)

A Movable-Wing Biplane

IN THIS biplane, designed by Prof. Albert Merrill of the California Institute of Technology, pitch control is obtained by altering the angle of the biplane cellule relative to the fuselage, and not by altering the angle of the whole fuselage relative to the ground as is generally done with the elevator. The plane in

which this feature is incorporated, CIT-9, was recently shown in the air at the Mines Field Air Meet.

The wings in this case are not built integrally with the fuselage and are not rigidly connected therewith. The biplane cellule is rigid with respect to the upper and lower wings, but just below the upper wing a two-strut cabane rigid with the wing is pivoted to a three-strut cabane which is rigid with the fuselage. The entire movement of the wing is about this pivot, and the entire biplane cellule moves as a single unit. There can be no alteration of the relation of the lower and upper wings to each other, and the only thing that changes is the relation of the wings to the fuselage.

Among the advantages it is claimed that if the controls are properly designed it is impossible for either the wind or the pilot to stall or nose-dive the machine. (Albert Merrill in *Western Flying*, vol. 4, no. 10, Oct., 1928, pp. 49–64, 2 figs., *d*)

FUELS AND FIRING

Hugel's Process for the Catalytic Hydrogenation of Tar Pitch

CATALYTIC hydrogenation of pitch by the usual process is impossible because such catalysts as platinum, nickel, copper, and iron become poisoned rapidly by the sulphur content of the pitch. Professor Hugel, of the Petroleum College of the Strassburg University, conceived the idea of utilizing alkaline hydrates, such as sodium, potassium, and calcium, as catalyzers. It was found possible to hydrogenate naphthalene in the presence of sodium hydrate under a pressure on the hydrogen of 150 to 300 lb. per sq. in. and at temperature of 450 to 480 deg. fahr. Hydrogenation of anthracene is equally possible, and moreover the catalytic activity of the hydrates is not diminished by the presence of impurities and poisons. Hydrogenation of pitch takes place under a pressure of 1100 to 1400 lb. per sq. in. and temperature of 575 deg. fahr. in the presence of from 7 to 10 per cent of the catalytic material. There is obtained a highly fluorescent greenish liquid in addition to a black solid substance. As presently operated the method is such as to obtain a yield of liquid of 80 per cent. (Paper before recent Congress of Industrial Chemistry at Strassburg. Abstracted through *Automotive Industries*, vol. 59, no. 20, Nov. 17, 1928, p. 693, *d*)

INTERNAL-COMBUSTION ENGINEERING (See also Railroad Engineering: New Diesel-Electric Locomotives for the Russian Railways)

The Gaw Single-Sleeve Engine

THIS engine was invented by Luther A. Gaw and developed in the laboratories of the Massachusetts Institute of Technology. The sleeve is so constructed that no harmful burning occurs around the edges of the ports, the simple up-and-down reciprocating motion of the sleeve giving a sharp opening and cut-off. The weight of the sleeve is very small, and consequently it is capable of being operated at high speed. Lightness is achieved by constructing the sleeve of steel tubing. The sleeve is sandwiched in between the piston and cylinder wall.

The design of the camshaft is such that it may be built extremely rigid, thereby eliminating the torsion or twisting that occurs in the eccentric shafts of most sleeve-valve motors that are now made. The contact combustion chamber with the exhaust port on a lower level than the intake gives good turbulence to the entering gas and makes possible what is known as a "stratified charge"—a condition where the new gas forms a layer at the top of the cylinder next to the spark plug, and the exhausted dead gas remains between it and the piston top. While its valve timing is somewhat limited, the single sleeve offers enough range of adjustment for ordinary conditions. Because of the compact combustion chamber the engine has a very high compression ratio.

Several engines have been built for experimental purposes and

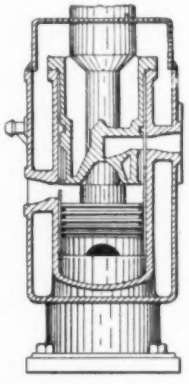


FIG. 2 CUTAWAY SECTION OF THE GAW SINGLE-SLEEVE ENGINE

have been tested on the road and on dynamometers. Beyond question these tests have shown that the motor is practical, that it may be produced economically, and that it is possible to refine its design and thereby achieve an efficient and smoothly operating motor. (*The Technology Review*, vol. 31, no. 1, Nov., 1928, p. 19, *d*)

The Packard Aircraft Diesel Engine

THIS engine was developed by the Packard Company in collaboration with Dr. Herman Dorner (of Germany). It is a radial type and said to have a sustained output of 200 hp. for 600 lb. of metal weight. No exact constructive details are made public. It appears, however, that the fuel is injected substantially at the end of the compression stroke; pure air only without admixture of fuel is compressed; and ignition of the fuel takes place spontaneously at the temperature corresponding to compression. Injection, however, is so timed that combustion takes place more nearly at constant volume than at constant pressure, with the result that maximum firing pressures greater than 860 lb. per sq. in. are obtained.

A Dorner engine generally similar to that used by the Packard Company has been described by Prof. Kurt Neumann in *Zeitschrift des Vereines deutscher Ingenieure*, vol. 71, no. 22, May 28, 1927, and the remainder of the article here abstracted deals with the engine there described. (*Oil Engine Power*, vol. 6, no. 11, Nov., 1928, pp. 732–734, 4 figs., *d*)

A Powdered-Coal Diesel Engine

TWO articles are devoted to this subject. In the first, some further details of the engine itself are given. It has a grinder which may be either belt driven or motor driven and in which the coal is crushed so that about 80 per cent will pass through a 100-mesh screen. A blower drives this to a separator where the coarse particles are led back to the pulverizer, while the fine dust along with some air passes into a chamber where the coal dust is intermixed with air. This mixed material is fed down into a screw conveyor. Two such conveyors are used—one to move the coal to the fuel valve, and the other to return any that does not enter the valve. In other words, there is a constant stream of fuel flowing to and from the fuel valve, and the speed of the screws is such that the air is kept mixed with the dry coal dust. The details of the fuel valve and the means of feeding it are given in the original article.

During the compression stroke the coal particles are heated to probably 800 deg. fahr., and there is no doubt that a partial distillation occurs. The combustion of the fuel largely proceeds as in the Diesel engine. The success of the engine is due primarily to the design of the coal-dust fuel valve and to the use of a small charge of oil to insure ignition. The engine is so designed that either coal or oil can be used, depending upon the price of the two fuels. The standard Diesel can be altered to use coal dust at a cost ranging from $5 to $10 per hp., depending upon the size of the unit. (L. H. Morrison, Mem. A.S.M.E., Associate Editor, *Power*.)

The second article deals with the economic possibilities of burning powdered coal in Diesel engines. In the opinion of the writer, if the simplicity of service inherent in the Diesel engine and the low price of fuel can be combined, the answer to a far broader application of the Diesel engine and cheaper production of power is given. The powdered-coal Diesel engine may be such a unit.

It is said that this engine as developed and operated in Germany has a fuel consumption of 0.66 lb. of coal per b.hp-hr., or about 1 lb. of coal per kw-hr. when operated with coal of 12,600 B.t.u. In this way the fuel cost of the Diesel engine falls below the lowest figures of fuel cost in large central power plants operated with high-pressure steam (H. Schreck, Mem. A.S.M.E. Both articles are published in *Power*, vol. 68, no. 19, Nov. 6, 1928, Mr. Morrison's on pp. 746–747, 4 figs., and Mr. Schreck's on pp. 748–749, 1 fig., *cg*)

MARINE ENGINEERING

The First Powdered-Fuel-Fired British Ship

THE steamship *Stuartstar* of the Blue Star Line operating between London and Buenos Aires, is a vessel of 10,500 tons, equipped with four Scotch boilers, two single-ended and two double-ended. One of the single-ended boilers was converted to powdered-fuel firing on the Woodeson system. This installation consists of one turbo pulverizer direct-coupled to an electric motor and four Woodeson burners (Fig. 3).

During the voyage to South America and back some 13,000 miles were traveled and the powdered-fuel-fired boiler is said to have worked to the complete satisfaction of the engineers. The coal used was six shillings per ton cheaper than that used on the stoker-fired boilers, had a heat content of 12,900 B.t.u. and contained 13 per cent of ash with a fusing temperature of 1160 deg. cent., the volatile content of the coal being 32 per cent. The mean furnace temperature on the outward trip was 2440 deg. fahr. and on the homeward trip 2542 deg. fahr. The CO_2 content of the flue gases averaged 15 per cent, with a maximum of 17 per cent, as against 8.5 per cent with hand firing on the stoker boilers.

The company engineers estimate the fuel saving over hand-firing at about 15 per cent (this is apart from the fact that the cheaper coal was used). One of the outstanding features of the system is the higher average speed of the ship, due to continuous steaming, as against the intermittent steaming caused by the cleaning of fires in each watch. The engineers are so satisfied with their experience that one of the double-ended boilers is now being equipped with eight burners and a pulverizer. This means that the *Stuartstar* will sail on her next trip with half her boiler capacity on powdered fuel. (*Engineering and Boiler House Review*, vol. 42, no. 4, Oct., 1928, pp. 202 and 204, 1 fig., *d*)

MEASURING INSTRUMENTS

A Micrometer for Measuring Thickness of Varnish Films

AN APPARATUS has been developed by the Cambridge Instrument Co. in England whereby a mean reading over the whole of the surface of a film or layer of dry varnish may be accurately obtained. The dry film, the thickness of which it is desired to measure, is placed between two glass plates, ground and polished quite flat and of uniform thickness throughout. The apparatus works by means of electrical contacts and a micrometer screw. The operator wears a pair of head phones and at the exact moment of contact a click is clearly audible in the phones, obviating the need for any special care in operation.

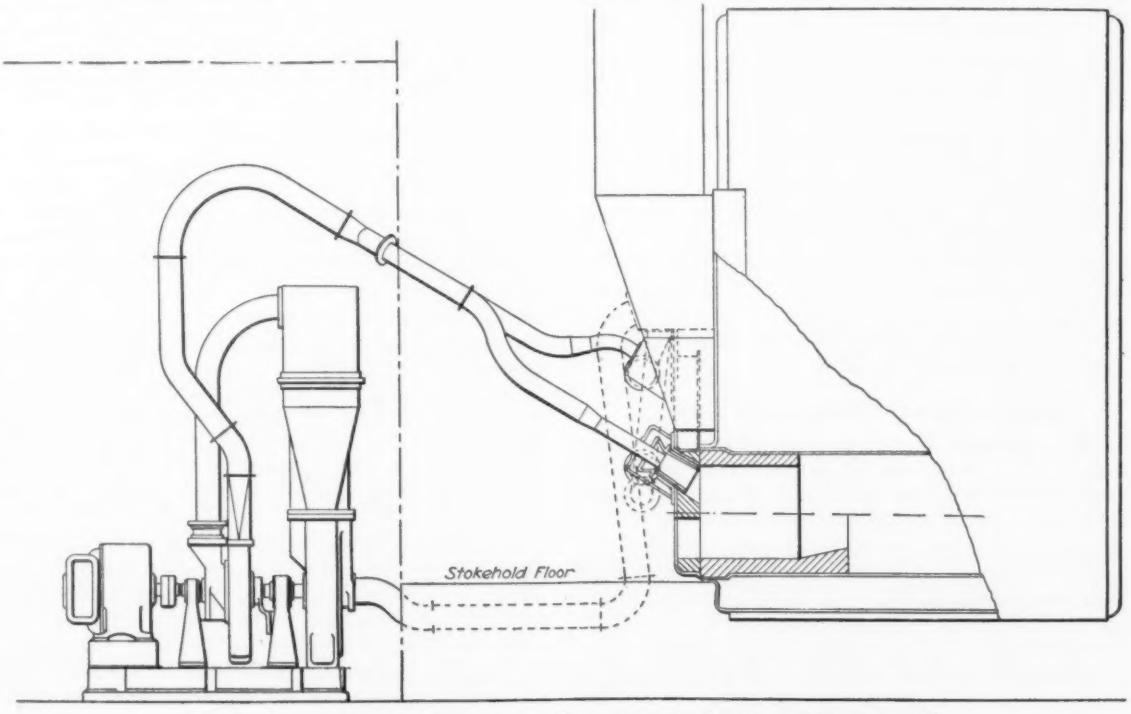


FIG. 3 ARRANGEMENT OF BURNER AND PULVERIZER ON STEAMSHIP "STUARTSTAR"

The method of obtaining varnish films is as follows: A varnish under examination is caused to flow down a sheet of tin amalgamated with mercury. The film is allowed to dry and then peeled off the tin. To use the instrument the glass disks are first placed in position and a reading taken without the film, showing their combined thickness. The film is then placed between the glass plates and a reading obtained by difference. (*Journal of Scientific Instruments*, vol. 5, no. 10, Oct., 1928, pp. 323–324, 1 fig., *d*)

MOTOR-CAR ENGINEERING

An Oscillating Vibration Damper

THIS is a new form of torsional-vibration damper developed by Thos. J. Litle, Jr., chief engineer of the Marmon Automobile Co., and known as a "high-frequency oscillating modulator." It consists of a relatively light metal disk accurately balanced and mounted on a specially prepared rubber base on the crankshaft. It is said that in operation, at the first indication of vibration through the shaft, the modulator begins to oscillate at high frequency, building up slight tremors and counteracting crankshaft vibration in the early stage.

The theory of this device appears to be based on the following: Angular vibration of a shaft depends upon the speed of rotation and the number of impulses per revolution. The period of vibration of the shaft, however, is comparatively low because of its great mass. The period of vibration of the damper, on the other hand, is so high that there is a great number of oscillations of the disk to one of the shaft. The great restoring force of the rubber dominates over the inertia of the disk, which latter is a small mass. For a given number of vibrations of the mass of the shaft there is an endless number of possible harmonics, both lower and higher than the fundamental, but as one proceeds up the scale of these harmonics their effect upon the fundamental decreases. Therefore, through the normal range of shaft speed the possible periods of angular vibration of the shaft are slow as compared with the period of vibration of the damper, and the harmonic effect of the damper upon the shaft is too small to be noticed. The damping effect is probably due to the fact that the rapid period of vibration of the damper plate is independent of the variations of the speed of the shaft, and consequently catches and dampens the possible vibrations of the shaft at the very moment of their inception.

A special device to prove the existence of numerous periods was used in the experimental work at the Marmon factory. It is known as a vibration exploring mechanism and is essentially a triple tuning fork. It was made up in circular form and connected to the crankshaft. When the car was started away in second gear, for instance, three recurring notes were sounded. When driving in high gear at varying speeds, five distinct tones were audible, some of them representing periods that were not known to exist previously. (*Automotive Industries*, vol. 59, no. 17, Oct. 27, 1928, pp. 596–597, 4 figs., *d*)

Pulverized Coal as Fuel on Motor Cars

THE author calculates the cost of operation on gasoline and coal under British conditions, assuming that the coal would be used in a producer of 80 per cent efficiency. He finds that under these conditions a vehicle can be operated for 15 hr. on coal for about the same cost as for 1 hr. on No. 3 spirit. He then proceeds to certain practical considerations in connection with the use of coal. No description of any specific apparatus is given.

It is desirable to pulverize the coal before use, with the object of increasing the area of the coal surface exposed to the heating and thermochemical conditions existing in the gas producer, in which it is converted into gas prior to use in the engine. By this means the surface area of the coal is enormously increased, with a corresponding reduction in the bulk of each coal particle; and as such small particles are instantaneously gasified, and as has already been proved the greater the speed of distillation and/or gasification the greater the thermal value and quality of gas obtained, quite a small producer would be able to supply sufficient gas to run the engine of any vehicle.

A further and important feature of this system is that it is only by previous pulverization of a solid fuel that correct scientific fuel gasification is attainable, as each individual particle of coal passes through exactly the same thermochemical process as any other particle. In the usual types of gas producer employed at present the enormously larger lumps of coal used are dissolved or burn away from their exterior, and the gases emitted during the process must pass through the bed of fuel varying from incandescent coke to raw, cold coal, according to the position in the retort in which the gas atom is born; consequently exact and scientific control of the gasification process is not possible, so that all commercial gasification processes at present in use give an average final result rather than a desirable result. (F. Umpleby in *Motor Transport*, vol. 47, no. 1234, Nov. 5, 1928, p. 532, *d*)

POWER-PLANT ENGINEERING

An Automatic Coal-Pulverizing Plant

THE Fitchburg Paper Co. at Fitchburg, Mass., recently installed a unit consisting of a 1000-hp. Bigelow-Hornsby boiler with slag screen and a Ljungström air preheater to operate at 250 lb. steam pressure. The fuel is to be supplied by two Riley Atrita unit pulverizers, each of which delivers its fuel to a Riley flare-type burner located in the front of the boiler. One of the pulverizers is to carry the load, the other being for use when the first one is being cleaned or overhauled. The furnace is 13 ft. 8 in. from front to rear wall and 19 ft. 4 in. wide. The front wall and the bottom of the furnace are air-cooled. The pulverizer embodies the most recent improvements. Among other things, the upper skirt is slotted so as to admit the travel of an adjustable knife which peels the desired amount from the circumference of the cylinder of coal. The thickness of the slice of coal is adjustable by moving the knife inward or outward by means of a handwheel. This type of feeder is said to give a very positive and uniform feed, even when the coal is of high moisture content.

The pulverizer is of the two-effect type. In the first effect the coal is dried by air from the preheater, which reaches the pulverizer at a temperature of about 300 deg. fahr. It is then broken up by a series of swing hammers pivoted to the rotor hub. These hammers are held in a radial position by centrifugal force. The second effect or fine-pulverizer compartment consists of alternate rows of moving and stationary pegs. The travel of the coal through the maze of these pegs is of a complex nature, because of the many eddy currents and vortices formed. This action is necessary for efficient pulverization and drying of the coal. If no stationary pegs were provided the action of the moving pegs would tend to revolve the entire mass of coal in the machine so that the pulverization would not be nearly as efficient. From the second effect the coal passes into the fan housing, which is an integral part of the machine but separated from the pulverizing housing.

The pulverizing chambers of the units are lined first with steel plate and then with a plate of special metal having unusual properties to resist wear and abrasion. The hammers are also made of a metal of special hardness. The hammers are pivoted to a heavy center plate and are reversible, so that when one surface wears they can be turned around and the other surface used. This constitutes another special feature of the Riley Atrita, the manufacturers having endeavored to bring about low maintenance wherever

possible. The fan also has renewable blades and they are easily removed and replaced, being held in place by four bolts.

The combustion is controlled by the Craig system, which provides for complete automatic regulation of the pulverizing equipment from the feeding of the coal to the pulverizer to the delivery of the combustible fuel to the furnace.

The discharge pipe from the pulverizer is connected to a flange at the inlet to the Riley flare-type burner. At the outlet of the chamber where the pipe enters are a number of vanes arranged parallel to the axis and at an angle to the pipe radius. At the end of the pipe is a coal spreader which is carried on a pipe projecting through the outside cover plate of the chamber. This coal spreader is adjustable and held in position by a screw. The pipe is contained in a plenum chamber, one side of which sets against the furnace wall. The opening in the plenum chamber coincides with a similar opening in the furnace wall. Secondary air is admitted to the plenum chamber through the damper. Within the plenum chamber and surrounding the inlet pipe is a set of vanes the axes of which are parallel with the axis of the pipe.

The pulverized coal, carried in suspension by primary or conveying air, enters the chamber through the flanged connection. The stream is given circular motion within the chamber and enters the pipe while revolving about the axis. Since this motion tends to cause the coal stream to travel in a zone adjacent to the inner surface of the pipe, the vanes are arranged to divert the stream toward the center. The coal then passes to the tip of the pipe, completely filling the space between the pipes. The vane breaks the coal streams into a number of stratified streams, and divert these strata into a conical form or flare.

Secondary air, supplied under pressure from a fan, passes the dampers which control the quantity of air flowing, and is given a whirling motion in passing between the vanes. Mixing of secondary air with primary air and coal occurs beyond the tip of the burner. The coal stream issuing from the tip in the form of a flare is violently whipped by the stream of secondary air issuing through the vanes, the two streams being in rapid motion.

By reason of adjustments which can be made by the coal spreader, the general shape of the flame can be adjusted. By moving the coal spreader forward and backward the flame can be shortened or lengthened. By adjusting the vanes, the sides, top, and bottom of the flame can be flattened to prevent any impingement against the boiler walls. The burner is installed entirely outside the furnace front wall, and this makes for low maintenance.

At a test when Springfield, Cambria County, coal was used, showing on an analysis carbon 73.44, volatile 19, ash 6.99, sulphur 2.63, moisture 1.88, and B.t.u. of 14,000 as fired. an efficiency of 87.5 per cent was shown, which, to put it mildly, is an excellent showing. (*The Black Diamond*, vol. 81, no. 18, Nov. 3, 1928, pp. 15–16, 2 figs., *d*)

The Fatigue Strength of Steam-Turbine Blade Shapes

BLADE shapes of several different metals have been studied with a view to determining their ability to resist many cycles of reversed bending stresses. The specimens for the tests were cut from bars of metal having a cross-section of the same shape and size as the turbine blades. They were tested as rotating beams so that during revolution the specimen was subjected to a transverse bending moment which changed direction through a complete circle.

In every case more than 90 per cent of the estimated endurance limit of the material was developed in the blading specimens tested as fabricated, and the general conclusions seems justified that steam-turbine blades carefully socketed may be expected to develop nearly the full fatigue strength of the material from which they are made.

In an appendix is given a brief discussion of the general theory of the flexure of a straight bar of uniform cross-section, with special application to the flexure of steam-turbine blades. (Herbert F. Moore, Stuart W. Lyon, and Norville J. Alleman in *Engineering Experiment Station, University of Illinois*, Bulletin No. 183, Oct. 16, 1928, 36 pp., 16 figs., *e*)

RAILROAD ENGINEERING

New Diesel-Electric Locomotives for the Russian Railways

AS PREVIOUSLY noted in MECHANICAL ENGINEERING (vol. 47, no. 3, March, 1925, p. 212), the Russian Railways Administration placed abroad orders for Diesel-electric locomotives some few years ago. The results obtained with the first locomotive were so satisfactory that now several more have been ordered from Brown, Boveri & Co. Certain changes were introduced in these locomotives. In one of these locomotives ($2\text{-}E_0\text{-}1$ arrangement of the axles and five nose-suspended tramway-type motors) the ouput of the Diesel engine is 1200 hp. at 450 r.p.m. This locomotive is intended for freight traffic. Among the changes the following may be noted. Solid injection has been adopted instead of air injection. To be able to use the Diesel engine as economically as possible over the whole speed range without running into critical oscillations, the generator is no longer driven by the engine through a couple which is flexible with regard to longitudinal movements, but quite rigid as regards torsional movements. Instead a type of coupling with great torsional elasticity is used. The inherent period of oscillation of the system can thus be affected so that all critical speeds, including those of a higher order, lie outside the normal speed range of the locomotive.

Observations made on the first locomotive, in which the oil and cooling-water pumps were driven directly from the engine, showed that it was necessary to run the Diesel engine for a time after a journey had been completed in order to keep the cooling oil for the piston and the cooling water circulating for a longer period to reduce the temperature of those parts of the engine which had become very hot. If this were not done damage might result from the carbonization of the oil and the evaporation of the water. In the new locomotive, however, these pumps are driven by electric motors; the engine can therefore be stopped immediately at the end of the run. While the Diesel engine is standing idle, the pump motors are supplied with current from a battery large enough to keep them running until the engine has been cooled down sufficiently.

Certain electrical changes have also been made. Among other things it is proposed to provide the locomotive with electric braking, whereby the motors will be externally excited from the battery and run as generators, supplying their current to a series of resistances.

Mechanically the other types of locomotives do not differ from the one just described, although certain differences in electrical equipment are noted. (O. Schläpfer in *The Brown Boveri Review*, vol. 15, no. 10, Oct., 1928, pp. 298–299, *d*)

SAFETY ENGINEERING

Bullet-Proof-Glass Shield on Cold-Hubbing Hydraulic Press

IN COLD-HUBBING work it is necessary to have a hub made of extremely hard tool steel, the hub being forced by hydraulic pressure into a piece of very soft alloy steel. A common occurrence in this type of work is that the hub breaks and quite often some of the broken portions fly off at high speed from the original member.

When such a press was installed about a year ago at the Pitts-

field Works of the General Electric Company it was proposed to place a strong wire mesh to furnish protection to the operator against flying portions of broken members. But one of the workmen suggested that bullet-proof glass be used in place of wire mesh. The advantage in having a solid, transparent window was obvious, and the installation was effected in the following manner. A thin sheet of celluloid was placed against the bullet-proof glass on the side nearest to the work, allowing a small air space between the bullet-proof glass and a sheet of ordinary window glass. The reason for this was that the celluloid would interrupt small pieces from chipping bullet-proof glass, and in case the blow was severe enough to shatter the latter, the particles would be interrupted in the air before they came through to the operator. Similar windows were placed on the four sides of the press.

Not long after this protection window was installed one of the hubs broke; two portions of the hub struck the glass just about in the position of the operator's face as he was watching the progress of his work. The glass was shattered at the point where it was struck, but did not break through. (H. W. Lancaster, Tool Supervisor, General Electric Co., Pittsfield, Mass., in *National Safety News*, vol. 18, no. 5, Nov., 1928, p. 12, 1 fig., *d*)

SPECIAL MACHINERY

British Development in High-Speed Strip Rolling

DESCRIPTION of a plant for rolling light-gage brass strip up to about 7 in. wide, finishing at from 0.005 to 0.003 in. thick, as well as finishing on heavier gages from 0.04 in. down. This plant was installed at the works of Earle Bourne & Co., Ltd., Birmingham, by W. H. A. Robertson, Ltd., Bedford. The mill is of interest because it is designed to operate at a rolling speed of 250 ft. per min. and yet is capable of effecting the maximum economic reduction per pass, i.e., from 49 per cent to 45 per cent of the thickness after annealing. The rolls are of chrome alloy steel, 10 in. in diameter by 10 in. face.

The roll housings are of cast steel and of a special pattern. The rolls are ground truly parallel, i.e., without camber. Adjusting screws with specially fine-pitched threads and large diameters operating by simple heavy wrenches were adopted. Because of the high speed and large reduction the matter of bearings was especially important. The "flood"-lubrication roll-bearing system developed by the author of the paper in cooperation with A. J. Bourne has been adopted. This bearing consists essentially of totally enclosed bronze bearings, each bearing being in one piece, and entirely covering the roll neck, thereby excluding all dirt, grit, and abrasive material, having ample bearing surface on the loaded side, the remainder forming an oil bath, through which a large volume of oil at low pressure is continuously pumped, with the result that a continuous oil film is maintained over the bearing surfaces; besides which any heat generated is continually carried away by the oil which is returned without appreciable loss to the reservoir, after passing through strainers, and is then cooled by means of a pipe coil through which water is circulated. As a further precaution the bearings are internally cooled by water circulation, although this has proved to be hardly necessary.

The roll drive is of the regular type. The main reduction gears are of steel with machine-cut, fine-pitch, double-helical teeth. The coiling of the strip is done by standard automatic coiling equipment supplied by the Torrington Manufacturing Co., Torrington, Conn. Two mills have been installed and the tonnage obtainable for these mills at 0.005 in. thickness rolling from about 0.035 in. is 4 tons per day. This means, of course, with four passes that the mills actually handle 16 tons of metal per day or 8 tons per mill.

Particular attention is called to the stiffness of the rolls, this being considered to be a very essential feature in a mill required for accurate rolling.

To quote from experience with 6-in. wide strip, which has been purposely rolled with a pronounced "middle," that is to say, thicker in the center than at the edges, a variation of from 0.036 in. in the center to 0.032 in. at the edges has been entirely removed in a pass through the rolls of the new mill taking approximately 40 per cent reduction to about 0.020 in., and the variation of thickness after this pass from edge to middle has not exceeded 0.0003 in.; of course with such an extreme case of correction a "buckled" strip would result.

The hardened steel rolls fitted to the mills have been proved to retain their surface and accuracy even under the severe working conditions of high speed and heavy reductions, and, after six months' work the roll bodies were found, by careful gaging, to be within 0.0002 in. of an exact parallel cylinder, the center being to this very minute extent smaller in diameter than the ends. This is neutralized, and probably a slight fullness or camber obtained during working, owing to the natural heating of the center of the roll. The fact that this expansion of the rolls takes place uniformly from the center and not unequally from the bearings, as is the case where the roll bearings are liable to heat up on one side or the other, insures that the strip will run straight and keep its position in the guides.

Figures are given as to power consumption and uniformity of the strip product, together with a formula for the maximum rate of deformation. From this it would appear that when the angle of contact arc is small, which means that the roll diameter is large as compared with the reduction effected, a higher rolling speed is practical and may be even advantageous without increasing the rate of deformation beyond the point where any increase in resistance can be detected. This is quite contrary to the opinion generally held. (C. E. Davies in *The Metal Industry* (London), vol. 33, no. 18, Nov. 2, 1928, pp. 413–416, 1 fig., *d*)

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society.

The Problem of Science-Afforded Leisure

AN ENORMOUS amount of human energy was expended in the construction of the pyramids and in beautifying ancient Greece and Rome, but it is doubtful whether any modern agency could afford to lavish the labor of hundreds of thousands of human beings on such an enterprise. In those ancient days slavery was held to be justified because slave labor enabled the patrician and the philosopher to have the necessary leisure to make their type of contribution to the welfare of the state. It is doubtless true that through the contributions of science the average individual today has an amount of leisure far beyond that experienced at any other period of the world's history, and that increase in leisure is almost directly in proportion to the contributions which science makes in the perfection of industrial processes and means for doing the world's work. Indeed, many hold that the vital problem of our times is the manner in which this additional leisure is to be invested, and we progress or retrogress as we employ this leisure constructively or destructively.—Dr. Harrison E. Howe in *Science*, November 23, 1928, p. 495.

Engineering and Industrial Standardization

The Mechanical Standards Advisory Council

"WHAT," "when," and "how" to standardize—to the general economic advantage, without embarrassment to the financially concerned interests in the mechanical field—are the basic questions which the mechanical industries undertook to solve through the medium of two conferences held April 7, 1926, and June 20, 1928. The formation of a Mechanical Standards Advisory Council was approved at the last conference.

The first conference, called by the A.S.M.E., answered the last of these three questions by unanimously determining that the procedure of the American Standards Association (formerly known as the American Engineering Standards Committee) is the method which should be employed in developing and/or promulgating a standard of sufficient scope to seriously affect more than a single group of interests.

The second conference answered the first two of these questions by approving the recommendations of the First Conference's Special Plan and Scope Committee that such functions should rest with industry itself; and by creating a Temporary Executive Committee with power, first, to further develop a basic instrument or Constitution for the necessary organization, the latter to be known as the Mechanical Standards Advisory Council; and second, to call a meeting at which this Council would be organized upon a permanent basis.

The functions of the Council as outlined in the Constitution adopted at the meeting are as follows:

1 To endeavor to obtain, at the request of any interested group, the desired cooperation of organizations in any standardization project in the mechanical field

2 To confer with any organization in the mechanical field interested in or carrying on work which eventually may be presented for action under the Rules of Procedure of the American Standards Association

3 To advise the American Standards Association on questions of policy relating to standardization applying to products of the mechanical industries

4 To serve as a general coordinating medium in the mechanical field, within the scope of the Constitution, By-Laws, and Rules of Procedure of the American Standards Association

5 To consider—

a The desirability and practicability of standardization projects within its field

b The order in which standards shall be developed

c The scope of projects

d Sponsorships for the necessary Sectional Committees, and

e The adjustment of conflicts and the clearing up of ambiguities; and

6 To follow up and expedite work in the development of standards. In accordance with its constitution the Council voted to designate the representatives of the S.A.E., N.M.T.B.A., A.S.A., M.S.S. of V.F.I., A.S.T.M., and the A.S.M.E. as the Executive Committee of the new council.

The permanent organization meeting was held in the Engineering Societies Building, New York, on Monday, December 3, 1928, and a large percentage of the sixty organizations having an interest in standardization in the mechanical engineering field accepted the formal invitation to join the Council and to appoint official delegates to represent them at this meeting.

Small Tools and Machine-Tool Elements

THE Sectional Committee which held the greatest number of meetings during the week of December 3 was the Sectional Committee on the Standardization of Small Tools and Machine-Tool Elements. Eight of its technical committees held meetings, and each of them made considerable progress toward the completion of their projects. Harry E. Harris, Chairman.

Technical Committee No. 3 on Machine Tapers. This Technical Committee, under the chairmanship of E. F. DuBrul, general manager of the National Machine Tool Builders Association, has been at work for some time, but only recently has it made progress toward the development of a definite proposal. In September, 1927, it sent out a questionnaire to 550 manufacturers and users of machine tapers with the following result:

	Number	Per cent
Number of copies of the questionnaire mailed	550	..
Total number of replies received	218	40
Vote on adoption of one taper (Question 1):		
In favor	164	75*
Against	23	...
Not voting	31	...
Vote on adoption of 3/4-in. taper (Question 2):		
In favor	118	54*
Vote on adoption of two tapers (Question 4):		
In favor	28	...
Against	148	68*
Not voting	42	...
Number of firms agreeing to adopt recommendations of the Committee	154	71*

* Per cent of replies received.

On the basis of this information the Technical Committee at its meeting in Pittsburgh in May decided to recommend a single taper. At this meeting it appointed a Sub-Committee on Taper

NEW AMERICAN STANDARDS

The following standards were approved by the A.S.A. during the month of November 15–December 15, 1928:

Standard Method of Test for Water and Sediment in Petroleum Products, by Means of Centrifuge. (American Standard.)

Standard Method of Test for Water in Petroleum Products and Other Bituminous Materials. (American Standard.)

Standard Method of Test for Steam Emulsion of Lubricating Oils. (American Standard.)

All three sponsored by the American Society for Testing Materials. Published by the A.S.T.M.

Series to formulate a recommendation for the angle or slope. At Cincinnati in September this Sub-Committee held a meeting and agreed on $^3/_4$ inch to the foot or 1:16, and requested three of its members to prepare a table of lengths and diameters for a complete series of machine tapers ranging from 0.356 in. to 3.270 in. at the large end. The Technical Committee held a meeting in New York on December 5, and after thoroughly discussing the report of its Sub-Committee it decided to distribute this report with an alternate proposal which was developed at the meeting. This alternate proposal is based on the use of the Morse tapers for certain sizes. The Technical Committee requested the Sub-Committee to prepare arguments for both of these proposals, and to distribute this information with the proposed standard series.

Technical Committee No. 4 on Spindle Noses and Collets for Machine Tools. This Committee held its organization meeting on Wednesday, December 5, and elected E. F. DuBrul, general manager of the National Machine Tool Builders' Association, chairman. The Committee outlined and discussed the scope of its work and appointed Sub-Groups to initiate the activity and to develop proposals for submission to the Technical Committee. Since the representation on this Committee was not considered comprehensive enough, it was decided to add to the personnel certain other branches of the machine-tool industry.

Technical Committee No. 5 on Milling Cutters. A very successful meeting of this Committee was held on December 5. At that time the proposed standards covering Nomenclature, Profile Cutters, and Keys and Keyways, copies of which had been previously circulated, were thoroughly discussed and revised. The Technical-Committee, of which C. W. Machon, Brown and Sharpe Manufacturing Company, Providence, R. I., is chairman, then recommended that they be distributed for criticism and comment prior to being submitted to the Sectional Committee for approval by letter ballot. The Sub-Group on Formed Cutters reported that their proposal was now in the hands of the printer, and that page-proof copies would be circulated within a short time for criticism and comment. No reports were received from the Sub-Groups on Hobs and Inserted-Tooth Facing Cutters.

Technical Committee No. 6 on Designations and Working Ranges was organized on December 5. E. F. DuBrul was elected chairman.

Technical Committees Nos. 7 and 8 on Drill Sizes and Drill Bushings. These two Technical Committees held a well-attended joint meeting at which the simplification and standardization of drill sizes was thoroughly discussed. Prior to the meeting Chairman Oxford had prepared a simplification chart showing a proposed 30 per cent reduction in the number of drills on the manufacturers' list. At the meeting C. E. Rundorff submitted a similar list proposing a still further reduction and a slight difference in the selected list. After full discussion the chairman appointed a Sub-Committee of three to study this material and other available data for the purpose of drafting a proposal which would meet the views of the Technical Committee. It is of interest to our readers to know that Carl J. Oxford, factory superintendent and chief engineer of the National Twist Drill and Tool Company, Detroit, Mich., is chairman of Technical Committee No. 7, and C. E. Rundorff, standards engineer of the Buick Motor Company, Flint, Mich., is chairman of Technical Committee No. 8.

Technical Committee No. 9 on Punch and Die Holders. The organization meeting of this Committee, which was held on December 5 at the A.S.M.E. Headquarters, was well attended. The Committee discussed the various punch and die holders now in use, and decided to initiate their activity by inviting industry to suggest the types of holders and dimensions which they desire to have standardized. Sidney Diamant, president of the Diamant Tool and Manufacturing Company, Newark, N. J., was elected chairman.

Technical Committee No. 11 on Chucks and Chuck Jaws. The organization meeting of this Technical Committee was held on December 4 and the Committee discussed fully the possibilities of standardization of these devices. At that time J. E. Lovely, chief engineer, Fay Automatic Lathe Division of the Jones and Lamson Company, Springfield, Vt., was elected chairman. Two Sub-Groups were appointed each consisting of five members. The first Sub-Group was appointed to initiate work on the standardization of chuck jaws, and the second, to undertake the standardization of adapters.

Technical Committee No. 12 on Cut and Ground Taps. This Technical Committee was formed with Charles M. Pond, of the Small-Tool Gage Division of Pratt and Whitney Company, Hartford, Conn., as chairman, to review a series of standard dimensions for cut and ground taps which have been previously prepared by an informal committee functioning under the auspices of the National Screw Thread Commission. The immediate purpose of the review was to ascertain if this material was of the kind which should be submitted for approval to the N.M.T.B.A., the S.A.E., and the A.S.M.E., the joint sponsors for the Sectional Committee on the Standardization of Small Tools and Machine-Tool Elements, and by them to the American Standards Association for approval as an American Standard.

Printer's-proof copies of the proposed standard had been distributed to the members of the Committee in advance of the meeting, so that the Committee came prepared to pass on this material. It decided to make slight revisions to certain of the proposed tables and on the inclusion of certain additional tables which the manufacturers of cut and ground taps are to supply.

Code for Pressure Piping

ONE of the large Sectional Committees organized under the procedure of the American Standards Association which took advantage of the recent Annual Meeting of the Society to hold meetings was the Sectional Committee on the Code for Pressure Piping. This Committee was organized in March, 1926, with the A.S.M.E. as sole sponsor. It now consists of 70 engineers representing 38 national organizations. Edwin B. Ricketts, research engineer, New York Edison Company, is its chairman.

Prior to the meeting of the Sectional Committee, Sub-Committee No. 2 on Power Piping and Sub-Committee No. 8 on Fabrication Details held meetings at which substantial progress was made in the developments of these two sections of the code.

At the meeting of the Sectional Committee, which was well attended, it was reported that the sections on Power Piping, Gas and Air Piping, Materials, and Oil Piping had been drafted and distributed in mimeograph form to the members of the Sectional Committee for comment. One of these Sections dealing with Oil Piping has been released by the Editing Committee for general distribution for criticism and comment.

Graphic Presentation

IN DECEMBER, 1926, the Sectional Committee on this subject held its organization meeting and set up six Sub-Committees on the following subjects: (1) Plan and Scope, (2) Terminology, (3) Time Series Charts, (4) Non-Time Series Charts, (5) Survey of Current Practice, and (6) Engineering and Scientific Graphs. Sub-Committee No. 2 on Terminology met in New York on December 7. Dr. D. J. McFall, Editor of *Survey of Current Business*, Bureau of the Census, Washington, D. C., is the new chairman, and it was decided to supplement the 26 definitions which have been circulated.

Revision and Addenda to Boiler Construction Code

IT IS THE policy of the Boiler Code Committee to receive and consider as promptly as possible any desired revision of the Rules and its Codes. Any suggestions for revisions or modifications that are approved by the Committee will be recommended for addenda to the Code, to be included later on in the proper place in the Code.

The Boiler Code Committee has received and acted upon a number of suggested revisions which have been approved for publication as addenda to the Code. These are published below, with the corresponding paragraph numbers to identify their locations in the various sections of the Code, and are submitted for criticisms and comment thereon from any one interested therein. Discussions should be mailed to the Secretary of the Boiler Code Committee, 29 West 39th St., New York, N. Y., in order that they may be presented to the Committee for consideration.

After 30 days have elapsed following this publication, which will afford full opportunity for such criticism and comment upon the revisions as approved by the Committee, it is the intention of the Committee to present the modified rules as finally agreed upon to the Council of the Society for approval as an addition to the Boiler Construction Code. Upon approval by the Council, the revisions will be published in the form of addenda data sheets, distinctly colored pink and offered for general distribution to those interested, and included in the mailings to subscribers to the Boiler Code interpretation data sheets.

For the convenience of the reader in studying the revisions, all added matter appears in small capitals and all deleted matter in smaller type.

PAR. P-332. Revise that section which appears on page 75 of the Code to read:

[1 Registered number.]

1[2] A.S.M.E. serial number which may be the manufacturer's serial number.

2[3] Name of manufacturer.

3[4] Maximum allowable working pressure when built.

4[5] Water heating surface in sq. ft.

5[6] Year BUILT [put in service].

[Items 1, 2, 3, 4, and 5 to be stamped at the shop where built.]

[Item 6 is to be stamped by the proper authority at point of installation.]

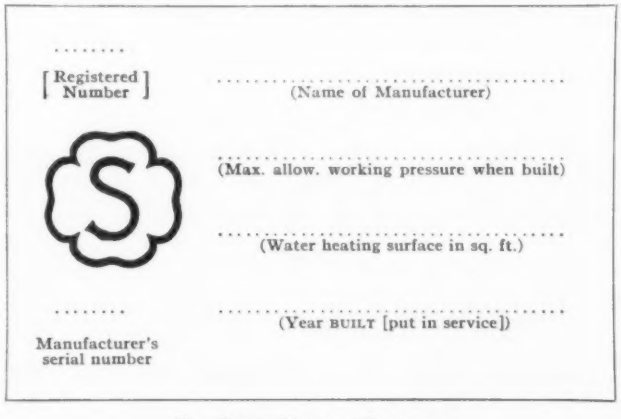

[Registered Number]
(Name of Manufacturer)
S
(Max. allow. working pressure when built)
(Water heating surface in sq. ft.)
(Year BUILT [put in service])
Manufacturer's serial number

FIG. P-22 FORM OF STAMPING

[Manufacturers, before using the A.S.M.E. symbol, shall be given a registration number by The American Society of Mechanical Engineers. This number shall be stamped directly on the boiler or placed on a non-ferrous plate. The registration number shall be placed not more than 1/ in. above the symbol and centering on it. Inspection jurisdictions shall be furnished by the Society with a list of registered manufacturers, with the corresponding registration numbers issued.]

(A sample data report sheet appears in the Appendix, opposite page 133.)

Stamps for the official symbol shown in Fig. P-21 are obtainable from THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

FIG. L-5. Replace letter "S" in symbol by the letter "L."

FIG. L-6. REVISED:

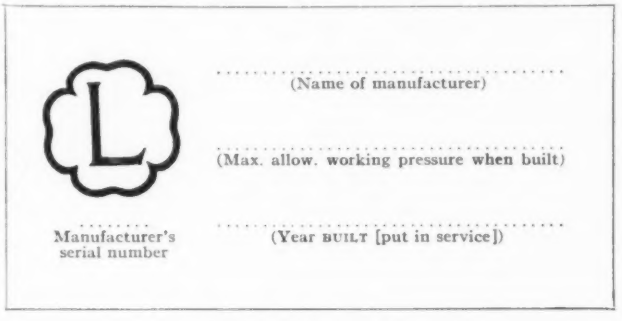


FIG. L-6 FORM OF STAMPING

PAR. L-82. Revise that section beginning on page 31 to read:

1. A.S.M.E. serial number which may be the manufacturer's serial number.
2. Name of manufacturer.
3. Maximum allowable working pressure when built.
4. Year BUILT [put in service].

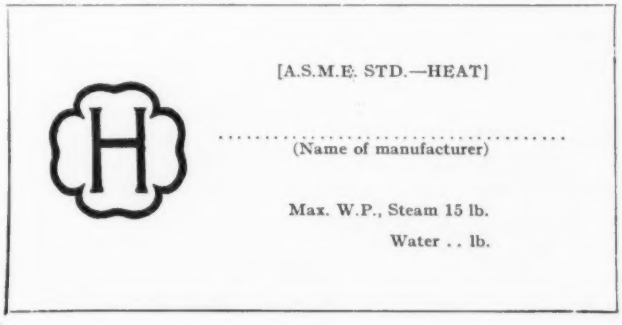
[Items 1, 2, and 3, to be stamped at the shop where built.]

[Item 4 to be stamped by the proper authority at point of installation.]

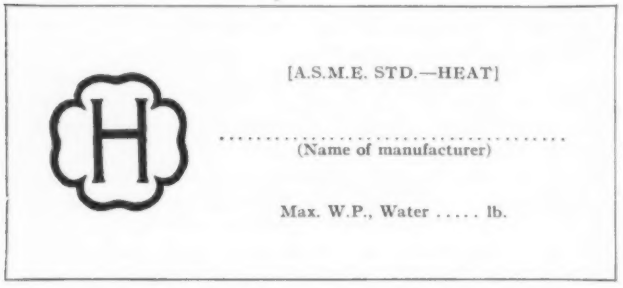
Stamps for the official symbol shown in Fig. L-5 are obtainable from THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

PAR. H-68. REVISED:

H-68. All boilers built according to these rules and no other boilers shall be STAMPED WITH THE SYMBOL AS SHOWN IN FIG. H-2A [marked A.S.M.E. Std.—Heat.], with the manufacturer's name and maximum allowable working pressure. These markings shall be stamped with letters and figures at least 5/16 in. high on some conspicuous portion of the boiler proper, preferably over or near the fire door. Boilers suitable for use for both steam and water shall have the stamps arranged substantially as follows:



Boilers suitable for use for water only shall have the stamps arranged substantially as follows:



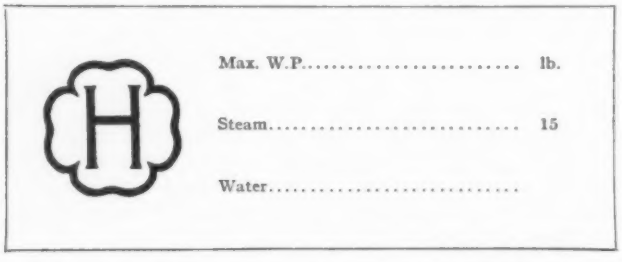
These stamps shall not be covered with insulating or other material. STAMPS FOR THE OFFICIAL SYMBOL SHOWN IN FIG. H-2A ARE OBTAINABLE FROM THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. [The symbol authorized for use on power boilers shall not be used on heating boilers, nor shall any] NO accessory or part of a [the] boiler MUST be marked A.S.M.E. or A.S.M.E. Std. unless so specified in the Code.

FIG. H-2A OFFICIAL SYMBOL FOR STAMP TO DENOTE THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS STANDARD

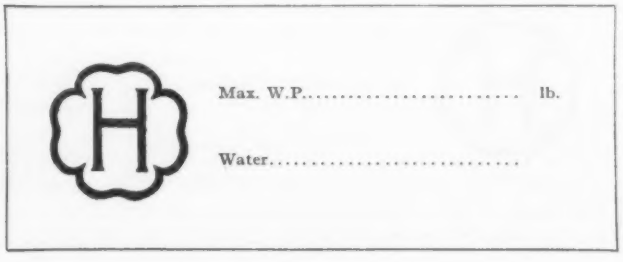
PAR. H-120. REVISED:

H-120. All boilers shall be plainly and permanently marked with the manufacturer's or distributor's name and the maximum allowable working pressure. All letters and figures shall be at least $^{5}/_{16}$ in. high.

The maximum allowable working pressure shall be stamped, cast, or irremovably attached to the front and rear cored sections of vertical sectional cast-iron boilers and on the dome section of horizontal sectional cast-iron boilers. The marking of maximum allowable working pressure on cast-iron boilers suitable for use for steam or water shall be as follows:



Boilers suitable for use as water boilers only shall be marked as follows:



All boilers built according to these rules, and no other boilers, shall be EITHER marked OR CAST WITH THE SYMBOL AS SHOWN IN FIG. H-2A [A.S.M.E. Standard as follows:

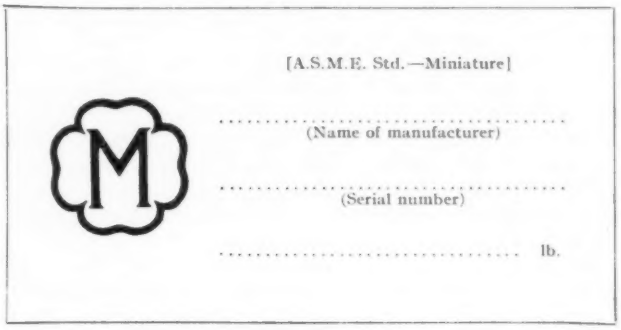
A.S.M.E. STD.

The symbol authorized for use on power boilers shall not be used on heating boilers.] STAMPS FOR THE OFFICIAL SYMBOL SHOWN IN FIG. H-2A ARE OBTAINABLE FROM THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

When an insulating or other form of covering is used, that portion of the front cored section of vertical sectional cast-iron boilers, and the dome cored section of horizontal sectional cast-iron boilers bearing the foregoing marking, shall either be provided with a removable cover plate or be left uncovered.

PAR. M-19. REVISED:

M-19. All boilers referred to in this section shall be plainly marked with the manufacturer's name, maximum allowable working pressure, which shall be indicated in arabic numerals,



SAMPLE OF MARKING

followed by the letters "lb.," and the serial number. All boilers built according to these rules shall be STAMPED IN THE PRESENCE OF THE INSPECTOR WITH THE SYMBOL SHOWN IN FIG. M-1 [marked A.S.M.E. Std.—Miniature]. STAMPS FOR THE OFFICIAL SYMBOL SHOWN IN FIG. M-1 ARE OBTAINABLE FROM THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. [The symbol authorized for use on power boilers shall not be used on miniature boilers built according to these rules, nor shall any], NO accessory or part of the boiler MUST be marked A.S.M.E. or A.S.M.E. Std., unless so specified in the Code. THE MARKINGS REQUIRED ON A BOILER SHALL BE STAMPED WITH LETTERS AND FIGURES AT LEAST $^{3}/_{16}$ IN. IN HEIGHT ON SOME CONSPICUOUS PORTION OF THE BOILER PROPER.

Individual shop inspection is required for miniature boilers in the same manner as for power boilers.

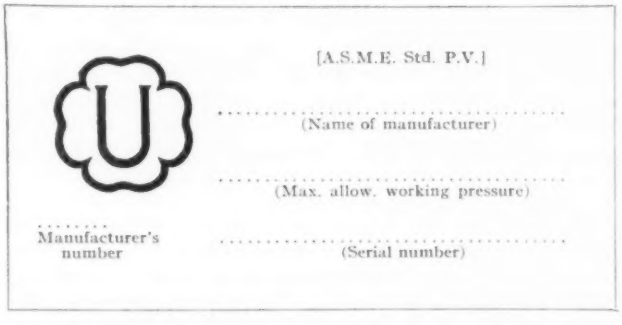
FIG. M-1 OFFICIAL SYMBOL FOR STAMP TO DENOTE THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS STANDARD

A data sheet shall be filled out for each boiler and signed by the manufacturer, this data sheet to include the most important items and to be numbered. In addition to this, the complete data sheet required for power boilers shall be filled out and preserved by the manufacturer for each lot of steel and each lot of boilers manufactured therefrom. The complete data sheet shall be marked to indicate to which boilers it applies and the manu-

facturer shall furnish copies of this complete data sheet when requested to do so by the owner of any one of the boilers. In requesting the complete data sheet the owner shall forward the number of the boiler which is stamped thereon in order that the manufacturer may readily identify the complete data sheet applying to the boiler.

PAR. U-66. REVISED:

U-66. Each such pressure vessel shall be STAMPED [marked] in the presence of the inspector WITH THE SYMBOL AS SHOWN IN FIG. U-2A, [A.S.M.E. Std. P.V.] and with the manufacturer's name and serial number and working pressure. These markings shall be legibly stamped with letters and figures at least $^5/_{16}$ in. high on some conspicuous portion of the vessel, preferably near a manhole, if any, or handhole, or on a name plate brazed or otherwise irremovably attached to the shell plate. These stamps shall be arranged substantially as follows:



The stamping shall not be covered permanently with insulating or other material. STAMPS FOR THE OFFICIAL SYMBOL SHOWN IN FIG. U-2A ARE OBTAINABLE FROM THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. [The symbol authorized for use on power boilers shall not be used on pressure vessels.]

(A sample data report sheet appears opposite page 4.)

FIG. U-2A OFFICIAL SYMBOL FOR STAMP TO DENOTE THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS STANDARD

Correspondence

CONTRIBUTIONS to the Correspondence Department of Mechanical Engineering are solicited. Contributions particularly welcomed are discussions of papers published in this journal, brief articles of current interest to mechanical engineers, or comments from members of The American Society of Mechanical Engineers on its activities or policies in Research and Standardization.

Value of Water Used for Water Power

TO THE EDITOR:

In the case of a water-power development the value of the water used is really the value of the water privilege or water rights, including land occupied by the development. The value of the water rights will vary inversely with the construction cost of the development, the rights being worth more in the case where the site has such natural advantages as large available head or excellent dam site or other features which will permit a development at low cost and therefore low fixed charges, which represent nearly the whole cost of water power.

To illustrate, assume that the wholesale price of power at the switchboard is 1 cent per kw-hr. Allowing 0.05 cent for operating costs (labor, etc.) and 10 per cent profit or, say, 0.1 cent per kw. leaves $1 - (0.05 + 0.10) = 0.85$ cent per kw-hr. which can be allowed for fixed charges.

To produce one kilowatt of water power continuously will require a generator capacity of perhaps 2 kw. to take account of load fluctuations, or about 2.67 hp. of wheels.

Yearly fixed charges will then be $0.85 \times 8760 = \$74.50$ for a plant of 2.67 hp.

At 10 per cent yearly for fixed charges this will be \$745 for 2.67 hp. or \$277 per hp. That could be expended initially to sell the power at 1 cent per kw-hr. with a profit of 10 per cent.

Such a plant under a 100-ft. head would require about 0.15 sec-ft. of water or about 0.1 m.g.d. of 24 hr. or 36.5 million gallons a year.

A water-power development may cost as low as \$50 per horsepower of capacity; this would be, however, a plant of unusually low cost. Taking a range of construction cost from \$50 to \$250 per hp., the value of the water would be as follows:

\$50 per hp. cost:

$$\text{Fixed charges} = 0.10 \times \$50 \times 2.67 \text{ hp.} = \$13.30$$

$$\text{Value of water} = \frac{\$74.50 - \$13.30}{36.5} = \$1.68 \text{ per million gallons.}$$

\$250 per hp. cost:

$$\text{Fixed charges} = 0.10 \times \$250 \times 2.67 \text{ hp.} = \$66.50$$

$$\text{Value of water} = \frac{\$74.50 - \$66.50}{36.5} = \$0.22 \text{ per million gallons.}$$

The range in value of water is then from about \$1.70 per million gallons in the case of unusually good water-power sites to \$0.20 per million gallons for relatively poor sites.

It we take an average of these two figures as representing the average water power it is substantially \$1.00 per million gallons—keeping in mind the basis of the sale price of 1 cent per kw-hr., with 10 per cent profit, and also the fact that a 100-ft. head has been assumed.

If the head were 50 ft., and this is perhaps more common than 100 ft., it would take twice as much water and hence the value of the water would range from \$0.85 to \$0.10 per million gallons or an average of about 50 cents per million gallons. This last figure is perhaps a fair figure for comparison with a process-water value of \$2 to \$3 per million gallons.

H. K. BARROWS.[1]

Boston, Mass.

This Month's Cover

THE photograph on the cover this month gives us a picture of the new School of Engineering at Princeton University, formally dedicated on November 15, 1928. The building, collegiate gothic in style, cost \$500,000, and has been in use since early October, although it was completely finished but recently.

The housing facilities and the equipment planned for the school will provide for training in laboratory practice and machine operation, investigation of machine action, and engineering research. All equipment has been planned to bring the student into contact with typically commercial machines.

[1] Consulting Engineer. Mem. A.S.M.E.

The Conference Table

THIS Department is intended to afford individual members of the Society an opportunity to exchange experience and information with other members. It is to be understood, however, that questions which should properly be referred to a consulting engineer will not be handled in this department.

Inquiries will be welcomed at Society headquarters, where they will be referred to representatives of the various Professional Divisions of the Society for consideration. Replies are solicited from all members having experience with the questions indicated. Replies should be as brief as possible. Among those who have consented to assist in this work are the following:

ARCHIBALD BLACK,
Aeronautic Division
A. L. KIMBALL, JR.,
Applied Mechanics Division
H. W. BROOKS,
Fuels Division
R. L. DAUGHERTY,
Hydraulic Division
WM. W. MACON,
Iron and Steel Division
JAMES A. HALL,
Machine-Shop Practice Division
CHARLES W. BEESE,
Management Division
G. E. HAGEMANN,
Materials Handling Division
J. L. WALSH,
National Defense Division
L. H. MORRISON,
Oil and Gas Power Division
W. R. ECKERT,
Petroleum Division
F. M. GIBSON and W. M. KEENAN,
Power Division
WINFIELD S. HUSON,
Printing Industries Division
MARION B. RICHARDSON,
Railroad Division
JAMES W. COX, JR.,
Textile Division
WM. BRAID WHITE,
Wood Industries Division

Fuels

Coal for Stoker Producing Insufficient Agitation

F-1 On a New England single-retort underfeed-stoker installation, the maximum mechanical adjustments possible still do not permit sufficient agitation to keep porous the fuel bed of the New River nut and slack used. Suggestions are solicited as to the names of specific semi-bituminous (or "smokeless") mines commercially adjacent for tidewater shipments, producing the least caking, most free-burning coal possible for semi-bituminous. High ash fusion and form factor producing a minimum of dust are, of course, also desirable.

A suitable coal can be obtained through the tidewater port of Hampton Roads and from the Kanawha District of West Virginia, either four or five Kanawha Split coals being satisfactory. Without knowledge as to what particular stoker is used, the writer would say that he has had many similar experiences and found the answer in one of the above-mentioned coals. (Allyn F. Gibson, Advisory Engineer, Fuel Engineering, Huntington, West Virginia.)

Stoker-Fired Midwestern Coals

F-2 Under what conditions are underfeed stokers economically justifiable on midwestern coals such as those of Indiana Illinois, Oklahoma, etc.? What maximum efficiencies have been obtained, and under what conditions of load factor and ash fusion? What did the maintenance run under these conditions?

Underfeed stokers are economically justifiable for loads of from 250 per cent to 300 per cent of rating, depending on furnace construction and grate area.

Efficiencies of 76 to 77 per cent may be obtained on boiler, stoker, and furnace when burning 35 lb. of coal per sq. ft. of grate surface in a furnace having refractory walls, or 50 lb. per sq. ft. in a furnace having water-cooled walls.

Ash fusion, 1900 deg. fahr. and higher. Load constant at these burning rates, efficiencies dropping off at lower and higher rates. Maintenance of material, from 3 cents to 10 cents per ton of coal, depending on the coal and the load carried. (Collison Craig, Consulting Engineer, Riley Stoker Corporation, Worcester, Mass.)

Machine-Shop Practice

Cutting Compounds

MS-1 Is there available a cutting compound of a jelly- or grease-like nature soluble both in oil and water?

The writer has had no experience with any compound of this nature, but is informed by a reliable authority that such a material, known by the manufacturers as a "synthetic product," has been placed on the market. It is a heavy, grease-like substance soluble both in water and oil. Attempts are being made to obtain further information, and it is possible that something of value will appear in a later issue of Mechanical Engineering in this department.

The National Acme Company, with which the writer is associated, makes practically universal use of a material known as "base oil." This is a very heavy substance, about 3000 viscosity, but is soluble in oil only—not in water.

This base oil has the following formula: Sulphur 8 per cent; saponifiable matter, 75 to 90 per cent; mineral oil, the balance to make 100 per cent.

This base oil is mixed with paraffin oil, the mixture being 10 to 1 for threading work, 15 to 1 for deep drilling and tapping in automatic screw machines, and 20 to 1 for ordinary turning work in automatic screw machines. In these mixtures the major amount refers to the paraffin oil and the minor amount to the base oil. (Guy Hubbard, Advertising Manager, National Acme Co., Cleveland, Ohio.)

Materials Handling

Sand-Blast Sand Disposal

MH-1 What are the opinions of readers of Mechanical Engineering regarding the possibility of disposing of sand from sand-blast rooms by blowing it through pipes to a river approximately 100 ft. away? Approximately three cubic yards of sand per hour must be handled. What size of fan or fans is recommended and where should they be located—at the source, point of delivery, or both?

(*b*) A possible solution of this problem follows: Assuming that the sand weighs 80 lb. per cu. ft., it would be necessary to convey 6480 lb. per hr. or 108 lb. per min. This would require 5530 cu. ft. of air per minute, and the pipe should be of such size as to have an air velocity of 6000 ft. per min. This would therefore require a 13-in.-diameter pipe.

Inasmuch as sand-blast sand is very abrasive, it is most desirable to lay out the system so that the sand does not pass through the fan, thus preventing frequent repairs. This could be accomplished either by installing a collector just ahead of the fan and exhausting the material, or, preferably, by introducing the sand into the system by means of an injector hopper with the fan just ahead of this hopper. At the bottom of the hopper the pipe would be reduced in size somewhat in order to increase the velocity of the air just below the hopper to prevent any possibility of the sand's piling up at the entrance of the system. Assuming that the piping from the fan to the river is practically straight, the estimated static loss in the system would be 9 to 10 in. water gage. To give some idea of the size of the fan equipment required I would recommend using a No. 21 Clarage improved exhauster, operating at 1150 r.p.m. and requiring 15.5 b.hp. to drive. A 20-hp. motor should be suitable for driving the fan, and could be either direct connected or belt connected to the fan.

The principal difficulty in installing a fan system to convey sand comes from the fact that it is very abrasive and the piping will be apt to wear out very rapidly, especially where any turns occur, and this fact should be taken into consideration in the final design of any such system. (S. H. Downs, Chief Engineer, Clarage Fan Co., Kalamazoo, Mich.)

Miscellaneous

MACHINERY CONTROL

M-1 Why is not more use being made in mechanical engineering of control of machinery by perforated strips?

Perforated strips are used in machinery to automatically produce various patterns, sizes, or results in the same general type of a product. Briefly, the reason why perforated strips are not more extensively used in the control of machinery is that there is such limited application for their use. When they constitute a convenient and practical means of control, their use is resorted to. For example, the Jacquard loom, used for weaving designs in carpets and silk goods, is equipped with perforated cards in which the positions of the holes control the positions of the warp-yarn strands, and consequently the design. Various patterns are obtained by changing the cards. The automatic player-piano is another example familiar to all, in which various rolls reproduce various musical selections. The Hooven automatic typewriter, in which a machine-perforated sheet is run through a special mechanically actuated typewriter, automatically reproducing truly typewritten letters, is another ingenious application of this principle.

Aside from the above-mentioned instances, their use in industrial machinery is limited because the perforated strips require delicate care and handling. Not many industrial products are made in such great variety as to demand the use of perforated strips, and, when varieties of product must be produced, other control methods are generally more adaptable. For example, in knitting machinery the position of the rib in men's socks varies with the size. This position is controlled by a detachable-link chain, moving slowly, and having an offset link which trips the machine for ribbing. The number of links in this detachable-link chain may be increased or decreased to change the tripping position of the rib. The same principle is used by the writer in automatically controlling the time required for setting various thicknesses and shapes of celluloid forms in special celluloid bowing presses.

Not infrequently machinery is caused to produce variations in products of the same general nature by merely changing a cam or cams, or even substituting entire camshafts. Automatic lathes and screw machines are examples from this class of machinery. An automatic screw machine could be designed for control at its slides, turrets, and feeds by a perforated sheet to suit the desired result, but the present cam-changing method is again more adaptable, practical, and durable. (Frederick Franz, Consulting Mechanical Engineer, New Haven, Conn.)

CUTTING SLATE FLAGS

M-2 What methods are employed in the cutting of slate flags such as are commonly used for blackboards?

Information on this question has been offered by a reader of MECHANICAL ENGINEERING, who does not divulge his name, in the form of an article on cutting slate, by H. H. Siegele, taken from an unknown publication. The following is abstracted from Mr. Siegele's paper.

A common method is to use a nail set or punch for making holes about one-half to one inch apart along the line of the proposed cut. After these holes are punched the section to be cut off is projected beyond a solid bearing, with enough pressure applied to break it along the line of the holes. While this method is satisfactory in many cases, it leaves a rough edge. A ripsaw is sometimes used in much the same manner as the carpenter rips a board. This also is unsatisfactory in that the slate quickly dulls the saw. A file or other steel tool is sometimes used to scratch deeply along the line of the cut on both sides of the flag. It is then an easy matter to break off the desired length by projecting it beyond a solid bearing and pressing downward.

Still another method is to place the line of cut directly over an opening between two solid supports such as 2-in. by 8-in. timbers laid 1 in. apart. Then with an old file held in contact with the edge at an angle of about 30 deg. with the plane of the flag, rapid progress may be made in cutting by striking the file short, snappy blows. Each blow of the hammer should cause the file to cut from one-half to one inch of slate. A stonecutter's chisel instead of the file may be used to advantage, and will no doubt be easier to handle. It must be held at such an angle that the force of the blow will be directed at an angle of about 60 deg. with the plane of the work to be cut. [EDITOR.]

Questions to Which Answers Are Solicited

GAS DISCHARGE THROUGH ORIFICES

AM-1 Two vessels of equal volume, A and B, are filled with gas of known chemical composition. The pressures in A and B are equal, and the common pressure is greater than standard atmospheric pressure. The density of the gas in A is different from that in B. Each vessel is discharging gas through an orifice into standard atmosphere. The orifices are so constructed that their areas and coefficients of discharge are equal. The areas of the orifices are such that the pressure in the main vessel will not be appreciably affected by the gas discharged in a unit time increment. What is the relation of the volume discharged from A to the volume discharged from B expressed as the ratio of the density of the gas in A to the density of the gas in B?

Correction

The answer to question MH-3, Sand-Blast Sand Disposal, published in the November, 1928, issue of MECHANICAL ENGINEERING, was incorrectly credited to S. H. Downs, Chief Engineer, Clarage Fan Co., Kalamazoo, Mich. This answer was offered by John F. Kendrick, Sullivan Machinery Co., Chicago, Ill. Mr. Downs' contribution appears in this issue under the Materials Handling Section.

MECHANICAL ENGINEERING

A Monthly Journal Containing a Review of Progress and Attainments in Mechanical Engineering and Related Fields, The Engineering Index (of current engineering literature), together with a Summary of the Activities, Papers, and Proceedings of

The American Society of Mechanical Engineers

29 West 39th Street, New York

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Contributions of interest to the profession are solicited. Communications should be addressed to the Editor.

BY-LAW: The Society shall not be responsible for statements or opinions advanced in papers or.... printed in its publications (B2, Par. 3).

Concerning Discussions at Society Meetings

IN A RECENT issue of *The Iron Age*, its editor, mindful of bitter experience at one of the sessions of the Society's Annual Meeting last month, points out that the best way to ruin a meeting is to have a large volume of written discussion which stifles spontaneous oral discussion. As usual, *The Iron Age* is right, and the Committee on Meetings and Program of the Society is entirely in accord with the editor in his feeling that written discussion should be read only by the writer of the discussion.

The Society has spent a large amount of time and effort in driving home to the members the importance of studying the presentation of papers before technical audiences. Moreover this activity will be continued at future meetings. A public-speaking coach was provided at the last Annual Meeting, and many of the authors took advantage of his services. He will be engaged next year, and members who present written discussion will also be given the opportunity to meet with him so that they may improve the forcefulness and emphasis of their remarks.

The Field for Humanics

HANDICAPS to professional progress which have their foundation in undesirable personal traits of character may be made of less consequence if attention is called to them and proper training undertaken at an early age. This is a field which engineering schools have developed only haphazardly if at all. Individual cases have received attention by particularly observant and tactful instructors, and many extra-curriculum lessons have been taught by precept and example in laboratory and classroom.

However, it is doubtful if any school has made a systematic effort to discover these defects and taken pains to correct them, beginning with the freshman with his crudities of adolescence and attempting the same progressive improvement in this feature of a student's endowments that they now make in his technical education. The system followed to date has been to cast into the rude mill of undergraduate life the raw material of youth with the hope that a process of abrasion will give the desired polish to the man.

Strong characters have been built this way, but with certain types the method is ineffectual and harmful, serving to accentuate undesirable traits rather than correct them. Thus sloth, inaccuracy, slovenliness may actually develop under the protection of a naturally brilliant mind, or an anti-social bashfulness become permanently ingrown by a solitary and reflective studiousness.

It will be interesting, therefore, to follow the success of the newly established course in Humanics which has been established at the Massachusetts Institute of Technology in connection with that institution's personnel work.

This course is designed, among other things, to determine those traits in freshmen which are likely to be handicaps to future success, and by a coordination of efforts of all instructors, correct as much as possible and at least call the attention of the man to these inherent defects in his natural endowments at as early a period in his career as possible.

The Purposes of the Society's New Publication Policy

THE new publication policy of the Society was inaugurated over a year ago. As in all changes of a far-reaching character, it brought forth a great deal of comment. Perhaps it is well, therefore, to review again the purposes for which the new plans were proposed, and to state the success that has been obtained in attaining these purposes.

One of the important purposes in mind in installing the new plan was to provide for printing and distributing the increasing number of papers without increasing expenses. The fact that thirty-one per cent more pages of material were printed by the Society during the fiscal year ending September 29, 1928, than in the preceding year and at a decreased cost of two per cent, indicates the success with which this purpose was accomplished.

A second purpose was to overcome the objection to the bound book of Transactions which contained only one-third of the papers presented each year, and to offset the difficulties with which the Committee on Publications was faced in selecting the papers to be included in it. One hundred and sixty-seven papers are included in the Transactions issued during the first nine months of 1928 as compared with the thirty-eight which appeared in the bound volume issued in 1927. This is an indication of the completeness with which the new Transactions serves the membership. Through the cooperation of the Executive Committees of the Professional Divisions broader experience has been brought to bear in the selection and editorial work on the various sections of Transactions, and as a result the material is now recorded in more usable form.

The third purpose of the new publication policy was to make the papers available more quickly. The bound book was issued from six to seven months after the close of the year in which the papers were presented. When the new scheme is entirely in effect the various papers will be in the hands of the members within three months after they have been presented, together with the discussions and the authors' closures thereto. At the present time the papers are reaching the members four months after their presentation, and the fact that they are being read is proved by the goodly amount of written discussion which is submitted after they have been received in their completed form.

The final purpose was to strengthen the Professional Divisions and give them desirable autonomy by providing a section of Transactions for each Division. This has undoubtedly had a beneficial effect on the work of the Divisions, and has stimulated increased activity on the part of the members of the executive committees of these exceedingly valuable organizations.

The Reference Value of "Mechanical Engineering"

CHANGES in the publication policy of the Society which resulted in Transactions appearing in a new form as a series of bulletins sponsored by the Professional Divisions have led to a new conception of the relative importance of the permanent value of MECHANICAL ENGINEERING as a source of reference material.

In the past, papers presented before the Society and appearing in MECHANICAL ENGINEERING stood an almost even chance of reappearing in complete form in the Transactions, the estimated permanency of their value being the criterion upon which the selection was based. With physical limitations of size dictated by the cost of publishing a volume of approximately 1300 pages, a choice of material was obviously necessary, and as a result Transactions never was a complete record; and because of the fact that a year's papers appeared in a single volume, publication was delayed so seriously that an earlier printing in MECHANICAL ENGINEERING of most of the important papers was a necessary part of the scheme. This defect of late appearance of Transactions being remedied in the new scheme, duplicate publication has ceased to be a paramount requirement, and another conception of the functions of these two publications of the Society is necessary.

Because MECHANICAL ENGINEERING is received monthly by every member of the Society and has a circulation in this and in foreign countries outside of the membership, it reaches readers of widely varying tastes and interests. Not being essentially a news magazine, although a considerable amount of technical news is featured in its pages, MECHANICAL ENGINEERING has the important function of bringing to the attention of its readers a record of the advances within the profession, and it has further an educational and interpretive function in relating the profession to other great forces in the world at large and in reviewing for mechanical engineers allied but distinctly different fields of human knowledge and endeavor. Accordingly, material is chosen for MECHANICAL ENGINEERING with these features in mind. It contains articles and papers presented before the Society which, in the opinion of the Publication Committee and the Editorial Staff, are of interest to a majority of the Society's members, and technical papers in any branch of mechanical engineering which are of unusual merit and deserve a wide circulation. Papers of special interest to the individual Divisions having a more limited application, are published in the Transactions of the Professional Divisions.

It will now be clear that the permanent value of MECHANICAL ENGINEERING is equal to that of Transactions, and that while papers before the Society may appear in either, they will seldom appear in both publications, except as certain Transactions papers may be found in condensed form in MECHANICAL ENGINEERING. Abstracts of all Transactions papers eventually appear in MECHANICAL ENGINEERING so that copies of them may be ordered as desired, and in line with this same service, abstracts will appear in the Transactions of a given Division so that all of the other Transactions papers appearing since the previous issue devoted to that Division will be adequately advertised to its members.

As a reminder of these changes to those who have been accustomed in the past to the practice of duplicate publication of papers presented at Society meetings, it is proposed to indicate on such papers appearing in MECHANICAL ENGINEERING whether or not they will be republished in the Transactions. The most logical procedure to follow is to preserve MECHANICAL ENGINEERING, for which a complete index may be obtained every year, or to clip for filing such papers as are likely to be of future value. The finding list of all papers is the Record and Index, which indicates where, if at all, every paper presented is published.

Putting Sound to Work

IT WAS jokingly said of the Chicago packers some twenty years ago that they had learned to make a profit out of every part of the pig excepting the squeal. Engineering has now arrived at the point where a squeal is becoming quite useful, and from its point of view, particularly in the control of apparatus, sound presents certain important advantages. In the first place, there is already available apparatus by which it can be transmitted all over the country—our extensive telephone communication system. Modern devices developed particularly in this connection with radio make it also possible to amplify sound to such an extent that it is perfectly feasible today to transmit from New York to San Francisco the heart beats of a newborn babe and make them sound at the Pacific end like pistol shots. The original sound emission, if loud enough, travels through practically any obstacle, and by means of simple apparatus can be controlled as to character. These and certain other factors not mentioned above permit us to use sound in a number of ways, and a few of them will be cited here with the sole purpose of illustrating the already highly developed stage which has been reached in its technical utilization. Enough publicity has been given to the Televox to make only a brief reference suffice. This is an apparatus so arranged that a certain sound effect produces a given reaction, and means are provided to make a report of the reaction by another sound. Thus, for example, a certain sound causes the Televox to connect with a water-level indicating device at a lake and report its finding by another sound easily decodable at the receiving end. More recently a sounding device has been installed on airplanes, while the lighting of a landing field has been so arranged that the flier can turn a switch on and have the field lighted by simply sounding his siren. This makes it possible to light emergency landing fields where no attendant is available for that purpose. There is no reason why the same device in a properly modified form should not be applied to railroads on their numerous unguarded crossings, the locomotive whistle operating the gates.

Another recent development in the same connection is a device for controlling the sighting of anti-aircraft guns, the arrangement being such that the sighting device is responsive to the whirring noise of the propeller and automatically lays the gun on the target.

The very important question of measuring the depth of water at sea has also been solved by the fathometer, which is a device based on the fact that since sound can be reflected from the bottom of the sea, the depth at a given place may be estimated by measuring the time elapsing between the emission of the original sound and the reception of its reflection.

The sight of a man tapping railway car and locomotive wheels with a small hammer to discover flaws is quite familiar, as well as the story of an old fellow who did it for fifteen years and then confessed he did not see how tapping a wheel in that way would make it any stronger. We are already approaching a time when complicated physical structures will be tested by the pitch of the tone emitted. In fact, it was the late Professor Howe of Colum-

bia University who some sixteen years ago predicted that the time would come when the architect would report that "the skyscraper emits a clear 'C' tone, but is defective in the third harmonic."

One feature in sound testing which has restricted its use is the fact that, in the words of the poet, "There is nothing more fleeting than the songs of yesteryear." This objection, however, has been completely eliminated by recent developments primarily intended for use in the so-called "talkies." Apparatus is now available by means of which sound can be easily and simply registered and reproduced at any time, with remarkable precision as to pitch at least. It is therefore fully possible now to test a structure, such as an airplane propeller, by sound, make a record of the result, and analyze it at leisure for the purpose of discovering, for example, the superimposed noises due to fluttering of the tips, etc. This method is already being used by an automobile manufacturer in testing fans. It is of interest to note how a development in one field helps those in other fields. The depth-measuring device is largely the outcome of another sounding device, the geophone, which is now used to discover underground locations of water, and may be used in the same way as a stethoscope is used by doctors, to find machinery troubles. The geophone itself, however, is but a development of a device for locating submarines by sound. Sound recording and reproducing is a development of the "talkies," while sound amplification is an outcome of efforts to reproduce in large volume the very faint signals given up by the ether to the antennae of a radio receiving set. Unquestionably one of the great reasons for the modern rapid progress of engineering is this interconnection and cross-fertilization of mechanical, physical, chemical, and electrical developments.

The Air-Cooled Aeronautical Motor

THERE are obvious advantages in the air cooling of aeronautical motors, one of the foremost being that such cooling eliminates at least one source of the so-called plumbing troubles which are still so common. Air, at least, cannot leak away or boil out.

From an operating point of view the aeronautical motor is eminently suitable for air cooling. It is always working with the vehicle moving at a considerable speed, and there is therefore no lack of draft. The aeronautical motor is not run with a retarded spark which produces overheating. On the whole, in the design of an air-cooled motor some weight may be saved. With the location of the radiators of water-cooled motors in the wings, the question of resistance of the latter lost its acuteness. On the other hand, however, the recently successfully solved problem of cowling aeronautical motors has done the same for the latter, so that from the point of view of power consumption to overcome the parasite resistance of the motor and its accessories the two types are about equal.

The predominance of the air-cooled motor is at least to some extent due to the fact that while the water-cooled motor, in so far as the questions of weight and efficiency of cooling are concerned, has reached the peak of its present development, the air-cooled motor is obviously still subject to a number of improvements which will increase its efficiency and possibly reduce its weight.

In the past the great obstacle to the development of the air-cooled motor lay in the difficulty of providing sufficient cooling for motors of large output. This particular difficulty has been apparently largely overcome, and today air-cooled motor construction is successfully undertaken in sizes which would have appeared prohibitive for this purpose only a few years ago.

Whether the water-cooled motor will meekly surrender its former predominance to its younger rival or whether some radically new improvements in water cooling will be introduced which will give it a new lease of life, remains to be seen. From past experience it would appear as if the latter would more likely be the case.

"1,000,000-Lb. Tensile" Steel

THERE is no reason why ultimately plain carbon steel should not have the above tensile strength. It is a remarkable thing that as the cross-section of a piece of steel, rolled or drawn, decreases, it becomes possible to increase more and more its tensile strength. A wire rod properly annealed is stronger in tension than a rolled beam made of the same material. Wire, however, is still stronger than the wire rod from which it is drawn, and the finer the wire the stronger it is, or rather the stronger it can be made. There is an excellent reason for this.

Any steel piece is only as strong in tension as its weakest part. Therefore its strength, be it a casting, a forging, a drawn or rolled product, depends primarily on its constitution, structure, and uniformity. If a thin wire of a given composition has a tensile strength of, say 300,000 lb., there is no good reason why a rail which has the same composition and has undergone the same heat treatment should not have the same strength, and yet it does not. The explanation of this is of course obvious, and that is, that one of the above conditions has not been really satisfied, which means that the rail has not been subjected throughout its mass to the same treatment or is not of the same composition throughout. From this point of view it may be interesting to consider in a general way how rupture of a piece of steel in tension takes place. Let us assume that a wire of a given cross-section ruptures under a load of 500 lb., which corresponds to a total tensile strength of, let us say, 200,000 lb. per sq. in. Suppose now that we take a hundred of these wires and suspend at the end of each of them a load of 500 lb. The hundred wires will then carry a load of 50,000 lb. Suppose now that we clamp all the hundred wires at the top and at the bottom—hang the top clamp on a hook from a crane and attach the same load of 50,000 lb., but in one mass, at the bottom. There is every reason to believe that ordinarily the bundle of wires will break, the reason being that when placed in a clamp (unless unusually good care is exercised) some of the wires will not carry their proportion of the load, which will thus be thrown on the remainder of the wires, and they alone are not capable of supporting it.

If now, instead of having the wires run parallel to each other we strand them, the break will even more certainly occur due to the fact that in addition to the purely tensile strains other strains arise due to stranding, and the total ability of the one hundred wires to support the approximately critical load is further reduced.

It is exactly this condition that is encountered in a piece of steel when it is subjected to tension. Because of the irregular distribution of crystals an effect is produced which makes it equivalent to a very inefficient wire rope where the individual members are not only stranded but kinked, looped, and, at times, broken. The larger the cross-section of the piece the more chance there is for such weakening irregularities, in addition to which the variation of heat treatment due to unequal penetration of heat to the various parts of the structure produces the same effect as would result from the use of several more or less arbitrarily selected sizes of wire in making up a wire rope. This is probably the principal reason why as we reduce the cross-section of a steel piece we are enabled to increase its tensile strength, because we succeed then in approaching more closely to uniformity. This is also the reason why certain forms of mechanical treatment produce stronger steel. While in rolling no fibrous

structure is imparted to steel, certain directional arrangements of crystals are achieved which produce, crudely speaking, a mechanical similarity to the parallel-wire arrangement described above. The smaller the piece the more it becomes possible to approach this condition, and the stronger is the steel produced.

There is another factor of great importance, and that is that when carbon steel is broken in tension the fracture occurs through the crystal and not through the so-called amorphous cement. It would appear, therefore, that if we could have a structure of steel wherein the amorphous-cement matrix would be continuous while the crystalline parts were embedded therein and completely surrounded, we should obtain a stronger structure. Moreover, the smaller the crystalline elements, and hence the thicker the intercrystalline walls of the amorphous cement, the stronger would be the structure. It happens that we are now able to control the crystalline structure to a comparatively small extent, but have not even approached the possibility of controlling the location of the steel crystals with respect to the amorphous cement. We know next to nothing as to the latter, and do not know whether it is truly amorphous or of such tremendously fine crystalline structure as merely to appear so to our rather crude means of observation. There is no doubt, however, that modern metallurgy is rapidly approaching the time when we shall be able to control the directional arrangement, the constituents of steel, and the relative distribution of the crystalline constituents within those which we now call amorphous cement, and when this comes to pass, steel of a tensile strength of the order of 1,000,000 lb. per sq. in. will become possible, with all the profound changes in machine design that this implies.

Status of Railway Mechanical Engineers

IT HAS been said that the mechanical-department officer lacks class consciousness when compared with other railroad department officials. It has also been said that a railway mechanical engineer considers himself more a railroad man than a mechanical engineer. Many well-informed railroad men believe that these attitudes have been the primary cause for the somewhat unfavorable attitude on the part of railway executives toward their technical men. Very little has ever been done to "sell" the technically trained man to the railway executive. The fact that a large proportion of the railway officers are non-college men who have arrived at their present positions through successful practical training, is one reason why the work of the mechanical engineer is given so little consideration. This is also the reason why so many graduates in mechanical engineering deem it advisable to "forget their college education" and pass off as "practical-trained men."

A good illustration of this attitude of mind was brought out in a discussion on one of the reports presented at the June, 1928, convention of the Purchases and Stores Division, A.R.A., at Atlantic City, N. J. It was proposed at this meeting that the engineer of tests should report to the head of the stores or purchasing departments instead of reporting to the head of the mechanical department. It was argued that the stores and purchasing departments were not concerned with the application or use of materials, but with quality only, and from the standpoint of the manufacturer were disinterested parties to any purchasing transaction by the railroad.

Of course, railroads are organized largely to meet local operating conditions, but it is hard to imagine under what circumstances the engineer of tests should report to the head of any department but the mechanical, unless the test department were placed on a par with other departments and the engineer of tests reported direct to the general manager or operating vice-president. The latter seems the more logical. Both the purchasing and stores departments work for the same company as the mechanical. Theoretically at least, an A.F.E. originates with the using department. If it does not, it should. In fact, quality means as much or more to the user than any one else. If the engineer of tests reports to the head of the mechanical department, he can entertain some hope for advancement. On the other hand, he has little chance of ever becoming chief purchasing officer or general storekeeper. If he reports to the general manager or operating vice-president, he can perform the test work not only for the mechanical department but for the maintenance-of-way, signal, electrical, or other department. Furthermore, the work he does will stand a better chance of recognition. Although there are three Class 1 railroads in the United States whose test engineers report to the chief purchasing officer or general storekeeper, it is difficult to imagine that any self-respecting mechanical engineer would be happy under such circumstances.

The American Society of Mechanical Engineers can render a real service to the railway mechanical engineer by working for the development of a higher professional consciousness. The Railroad Division's report on the mechanical engineer by its Sub-Committee on Professional Service, has started considerable thought on the part of railway executives, some of whom have already taken definite action toward increased utilization of technically trained men, but there is need for a broader professional viewpoint on the part of the railway mechanical engineer if he hopes to take the place in the industry that the importance of his work warrants.

Engineering in Woodworking

THAT engineering in woodworking is progressing rapidly was very evident at the Third National Meeting of the A.S.M.E. Wood Industries Division, held in Grand Rapids last November.

"Strain Relations in Wood," by Charles Norris, of the Haskelite Mfg. Corp., proved to be one of the most interesting topics presented at the meeting. In this paper Mr. Norris applied Mohr's stress and strain circles to wood, and claimed that with the help of a few experiments on wood the elastic theory could be reduced to the realm of trigonometry and algebra. The author was drawn into the use of his described methods to avoid waste in building dies for woodworking. An interesting discussion followed which had to do mainly with the advantages of predetermining properties of wood and plywood. Another paper of equal merit was one on "Engineering Characteristics of Plywood," by Thos. D. Perry, of Bigelow, Kent, Willard & Co., which was prepared to emphasize the strength quality of plywood rather than its use for the beautifying of furniture. The paper, besides covering the manufacture of plywood, discussed its uses and stated that its engineering possibilities were only discovered at about the time of the World War. In the discussion Mr. Norris stated it was important to remember that the real advantage of plywood is that its construction can be designed to suit the particular use one has in mind.

A session on wood as fuel proved to be a valuable addition to the meeting, as it called attention to the wasteful use of a waste product. Other papers presented were: "Efficiency Methods and Standards in German Woodworking Industries," "Automatic Woodworking Machinery," "Analysis of Causes of Forest Fires," and the "Progress Report on Reducing Waste by Improvement of Design and Use of Woodworking of Saws and Knives."

The meeting may be said not only to have contributed to the advancement of engineering in the field of the Division, but also, as one discussion pointed out, to have focused attention on the need of engineers—technically trained men—in woodworking establishments.

The 1928 A.S.M.E. Annual Meeting

High Lights of the Five-Day Convention as They Appeared to an Interested Observer of This and Other Past Gatherings of the Society

TO ATTEMPT a summary of the Forty-Ninth Annual Meeting of the A.S.M.E. in such a manner as to paint a vivid picture of this important event and at the same time interpret its meaning to those who were unfortunate enough not to attend it and therefore have no first-hand impressions of it, is not an easy task inasmuch as such an attempt must of necessity remain a series of personal impressions, with emphasis laid, it may be, in not just the quarter that another observer might have laid it. No attempt will be made in this review to cover more than the technical aspects of the program, the social and other special features having formed the subject of another account which appeared in the *A.S.M.E. News* for December 22.

ELMER A. SPERRY — PRESIDENT, 1929

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

EXTERNAL IMPRESSIONS

Externally, this meeting with its attendance of 2525, covering a period of five days filled with technical and social events so extensive that if run off consecutively as in the olden days more than five full weeks would have been necessary—externally this meeting imparted an impression of tremendous activity. From morning to night the foyer of the Engineering Societies Building, which was used for registration and general assembly, presented a busy and noisy scene. Behind the registration desks were members of the Student Branch of New York University and of the Society's clerical staff who received the visiting members and ministered to their needs. Uniformed pages bore messages from floor to floor. Eager faces reflected the enthusiasm of greeting old acquaintances. Students met their erstwhile instructors. Men talked excitedly with friends and former associates, slapped backs, and pumped arms. Elevators were jammed. Ladies slipped quietly into the headquarters set aside for their use, and pondered on the exuberant actions of their escorts—not a little tolerantly perhaps.

Upstairs, more activity. Four meetings in session simultaneously on three floors. Committees jamming every available corner of a sixteen-story building and overflowing excitedly into the Engineers' Club for lunch and dinner. Scraps of conversation. Interrupted greetings. Discreet inquiries about the identity of former friends not seen for many years. Attendants slipping through the crowd with precariously piled bundles of preprints of papers and paraphernalia of meeting machinery. A constant paging of familiar names that brought volumes of memories to old stagers and the itching of curiosity to younger men to whom these names were famous as textbook authors and leaders in a great profession. The mingling of much smoke and confused conversations. A peering at names neatly typed on lapel badges which proclaimed as well as his name a man's local section. And finally, for a moment of peace and rest, a retreat into one of the rear seats of a crowded meeting room where, under the gavel of an effective presiding officer and in respect to the speaker and the stenotypist who strained ear and eye to catch every word uttered in order to preserve it for the record, a few minutes of relaxation might be had even if the discussion of technical papers failed to rally a flagging consciousness. Such it was, five glorious days with a program so varied that a man was torn between the profit of technical discussion and the pleasure of personal contacts with friends and associates. Not a few who stopped long enough to consider the effects upon them of the process to which they were submitting themselves, attested sincerely to the stimulation of mind and imagination which this annual experience was once more affording them.

WHY IT RAN SMOOTHLY

But although this picture which has been drawn of the external aspect of the meeting may have impressed every visitor at the convention, it must have been equally evident to him that there were few flaws in the arrangements and that some one had considered carefully the details of meeting machinery. At the risk of emphasizing the service to the Society with which a properly constituted committee is charged as a major responsibility, it seems fitting to mention some of the precautions taken by the Committee on Meetings and Program to insure the success of this annual gathering of the Society. Much experience is gained every year in the conduct of meetings, and every year bears witness to improvement in the arrangements. It is the belief of the Committee that its functions do not cease, nay, that they merely begin, in the formulation of a program of events and technical papers. How best to present this program to the Society is the constant concern of the Committee. A paper poorly or inauspiciously presented may be ruined in its effect on an audience. To the end that the setting may be as perfect as possible, the mechanical details of the meeting room are most carefully attended to. Lanterns, blackboards, lights, and such machinery are made to function with accuracy and perfection. So that there shall be a practical understanding of duties and obligations between authors and presiding officers, a breakfast or luncheon precedes every session at which a dress rehersal insures that the actors in the day's drama shall play their parts

with assurance and precision. Following a custom established last year, a coach in public speaking was placed at the services of every author for private tutoring in the art of public address, for criticism of delivery, and for suggestions as to the quality and extent of presentation remarks. Thanks to the care that is being exercised in this direction, the proverbially inarticulate engineer is becoming adept at public presentations of his ideas, as observation of any of this year's sessions will truthfully attest.

An innovation of this year was the use of microphones and a public-address system in the auditorium, a system for intensifying the speech of those who need it, which suffers from none of the defects of distorted vocal tones or disturbing noises. This mechanism, under the control of an attendant, is modulated to suit the requirements of the speaker, and so perfectly did it function that few guessed that it was in operation.

THE TECHNICAL PROGRAM

For the names of technical papers and their authors, attention is directed to the list which was published on page 900 of the November issue and which is an able answer to the criticism that the A.S.M.E. is a "power" society. It is impossible to review adequately every paper, or to comment on every discussion. Preprints of the paper were available, and the discussion, with the corrected papers, will appear shortly in the Society's Transactions or in MECHANICAL ENGINEERING. There are, however, some observations upon these papers in general and upon some few of them in particular which will be given notice by the present reviewer because, in his opinion, they are significant and worthy of especial comment.

There was, for instance, that meeting of the Printing Industries Division on Friday morning at which the presentations, delivered without notes by all authors, were of such uniform excellence in respect to the interest aroused by them and the manner of delivery that the session as a whole is to be heartily commended. This excellent record made by one of the Society's youngest professional divisions is one to be envied and cumulated by the others, excellent as most of them were.

To one who has followed closely a dozen or more of these annual meetings, some interesting contrasts were presented by a study of the program. There was, for instance, no "keynote" session, so popular a few years back, and one looks in vain amid the wealth of excellent papers for one which would typify the quality and spirit of the entire lot. Again, it is to be noted that many subjects and many authors were not new to the Society's programs or its Transactions. The paper on Lubrication, for instance, by H. A. S. Howarth, recalls this author's previous contributions in this field and reminds us that there are some problems connected with the most elementary of mechanisms which are still subject to critical analysis and technological improvement. Wohlenberg's studies in radiation within the boiler furnace were productive of another communication to the Society, and in this connection it is worthy of note that the names of his collaborators, changing from year to year, indicate the double purpose which the author has achieved in educating not only his audience but students in his classes who have gone forth to take their places in the ranks of graduate practicing engineers.

STEAM TABLES REVISED

There was also to be noted the annual meeting of the Steam Tables Research workers, to whom Professor Heck proves such an active stimulant. To review the history of this group briefly is to return to the year 1920 when Professor Heck, baffled at the inconsistencies of authorities on the properties of steam, reviewed the fundamental equations of state and formulated his own equation as another attempt at interpreting the sometimes conflicting testimony of experimental evidence. To this more or less academic concern in existing confusion there were added the practical difficulties which for many years had confronted steam-turbine designers who found themselves forced to extrapolate into regions beyond the scope of experimental researches and with rather unsatisfactory results. A request from Geo. A. Orrok for designs for a 1400-lb. steam turbine provided an excellent starting point for a through going revision of the steam tables, and the influence of the General Electric Company was then brought to bear, through Ernest L. Robinson, upon the problem of formulating a new set of tables based upon accurately observed data covering the actual ranges of temperature and pressure demanded by the necessities of design.

An entente cordiale was therefore formed between the U. S. Bureau of Standards, Harvard University, M.I.T., and the General Electric Company, under the supervision of Geo. A. Orrok and Dean Arthur M. Greene, Jr., at a meeting in Cambridge Mass., June 23, 1921, which developed a modus operandi and a division of responsibility and labor; Dr. Davis undertaking the Joule-Thomson investigations, Dr. Keyes the pressure-volume-temperature determinations, and the Bureau of Standards the actual measurement of the specific heat of water.

Each year has seen an advance in progress. In 1925 a provisional total-heat-entropy diagram was presented through the instrumentality of the General Electric Company and the cooperation of J. H. Keenan and Dr. Davis, based on the data then available. The present meeting was the occasion of the publication of another, and more accurate, total-heat-entropy chart extending beyond the critical point and the promise of tentative steam tables within a year—truly an astounding fruition of the hopes of the early collaborators.

But in spite of all that has been accomplished, which has, fortunately, kept sufficiently ahead of a hard-riding practice threatening to overtake it, the question of a general steam equation still remains to be answered as the paper by Professor Heck, "A General Steam Equation?" (interrogation point to be noted) and the subsequent discussion brought out, and in spite of the simple expression which the famous English investigator has but recently reaffirmed.

SOME NEW TOPICS DISCUSSED

If measured by no other standard than its accomplishment in this field of research, the activity of the Society could be amply justified. But a rather lengthy digression in the field of steam must not blind us to the importance of other papers which had favorable and much-discussed receptions. In contrast to the "perennial" subjects which afford much interest to those closely in touch with the Society's publications, there will be noted among the titles subjects whose very modernity and immediate value are sufficient explanation of the large audience which greeted them. Chromium plating and Carboloy qualify in this class, and it was quite evident to an observer that there was a keen interest among the listeners in absorbing as much factual information as possible from the experiences and knowledge of the authors. One could easily surmise that many designers and shop managers had been charged by their superiors to make a special study of the possibilities of those newer elements in the ever-varying conditions of production. It was suggested by those discussing the very ably presented paper by Dr. Hoyt on Carboloy that industry might, as thirty years ago it faced the introduction of high-speed tools and their attendant changes in shop practice and machine-tool design, face now an equally important change, and the hope was expressed that a more closely coordinated group of engineers might cooperate in a research which would benefit all and not protract the readjustment which was bound to follow any revolutionary advance in the art of cutting metals.

ECONOMIC TREATMENT OF ENGINEERING TOPICS

Another interesting side light on the character of the papers presented was to be found in their strictly economic treatment of many of the subjects discussed. A number of outstanding papers might be cited to illustrate this observation, but suffice it to include those by Professor Roe, on the principles of jigs and fixture practice, by L. P. Alford and J. E. Hannum on a basis for evaluating manufacturing operation, and by Professor Christie on the steam accumulator as applied to central stations in handling peak loads.

Professor Roe's paper presented the economic principles underlying the design of jigs and fixtures, and by means of a series of formulas gave a method whereby justifiable expense in the way of work-holding devices might be estimated intelligently in advance. His paper was accompanied with a statement of the principles underlying the design of the details of these devices, and with a carefully prepared bibliography which supplemented his review so thoroughly that it may easily prove a contribution of prime importance to designers and plant managers.

The paper by L. P. Alford—whose "Laws of Manufacturing Management," presented at the 1926 meeting of the Society, won for him the Melville medal in 1927—and J. E. Hannum proposed a basis and methods for evaluating certain factors in the operation of manufacturing establishments. An analysis of manufacturing records and statistics was the basis on which the authors interpreted these factors, and the proposal was made that the kilo man-hour (1000 man-hours) be adopted as a standard in reporting and measuring performance in industry. A motion was carried to the effect that there be included in the next census of manufactures a statement of performance in kilo man-hours.

As may be expected by those who have read the paper, the discussion was lively, and not entirely favorable, although the objections seemed ably met by Mr. Alford in his rebuttal in which he called attention once more to the disclaimers and limitations which he and Mr. Hannum had recognized and noted deliberately in the paper. The reception which the paper has been accorded in financial and economic circles outside of the engineering profession stamps it as one of the meeting's important papers.

Professor Christie also met with some objections to his proposal of the use of steam accumulators for carrying peak loads in central stations, but here again, when the rebuttal was called for, one was left with the impression that, interpreted in the light of the author's own vision of his subject, little objection could be raised against the proposal and that it merited careful study.

COOPERATION OF OTHER SOCIETIES AND PROFESSIONAL DIVISIONS

Space will not permit even the barest mention of many other important contributions to the Society's Transactions. Much interest was displayed in the many symposia on methods of motor application and control, sponsored by the Machine Shop Practice Division, on illumination, held jointly with the Illuminating Engineering Society, on lubrication, on skid handling of interplant shipment, on mechanical springs, boiler feedwater studies, fluid meters, and on paper and ink as the raw products of manufactures and the conditions which affect them in the printing industries. There was a wealth of material by authors in this country and abroad on a variety of subjects and presented under the auspices of the Society's Professional Divisions. The Transactions of the Society and the pages of MECHANICAL ENGINEERING will bring all of these in due course to the attention of those interested.

Notice should be directed, however, to the important work which the Professional Divisions are doing in keeping their fingers on the pulse of the profession. This is reflected in the progress reports which were a feature of the technical program and which are to be found elsewhere in this issue. These surveys form the basis of a new aspect of the mechanical engineering status quo, and make profitable and interesting reading. They are also indicative of the scope of the Society's interests in the technical divisions of the field it is organized to serve.

OTHER FEATURES OF THE PROGRAM

Of the interesting and profitable Robert Henry Thurston Lecture which was delivered by Dr. Wheeler P. Davey, professor of physical chemistry at the Pennsylvania State College, on "The Elastic Properties of Materials as Shown by Crystal-Structure Investigations," it can only be said that a treat is in store for those who read what he had to say in a subsequent issue of MECHANICAL ENGINEERING.

The Presidential Address, "Consistency," is published as the leading article of this issue.

It is to be hoped that the omission here of specific mention of any paper or discussion will not be construed as a reflection upon its quality or importance. No attempt at inclusiveness is intended in this brief survey, and the papers mentioned are introduced more by way of illustration than to accord them particular prominence. The thanks of the Society and of the engineering profession are due equally to all those who gave of their time and their knowledge that this meeting might be a technical success, and that unofficial thanks is expressed in this brief review with the justified belief that it will be echoed by all who have profited by attendance at the meeting or by reading of the papers and discussions yet to be published. Surely this Society, which is approaching its Jubilee year, is living up to the traditions its founders set for it in the presentation and publication of technical papers.

There is other Society work equally as important as the technical sessions, and the remainder of this review is devoted to a survey of the activities of the various committees on research which perform such vital and important functions in the engineering profession. A report of the activities of the standardization committees will be found elsewhere in this issue on the pages regularly devoted to Engineering and Industrial Standardization.

The Annual Meeting of the Local Sections Delegates and the Student Branch activities were reported in the *A.S.M.E. News* for December 22.

RESEARCH AT THE ANNUAL MEETING

In the research activities sponsored by the Society one sees concrete expression of the new spirit of cooperation in industry through mutual self-help in the solution of common technical problems. One has but to glance at the program of research committee meetings and sessions at the Annual Meeting to appreciate the health and significance of this activity.

The power field was represented by committees on boiler-feedwater studies and condenser tubes, the machine-shop practice field by the committee on cutting of metals, the wood industries by a committee on saws and knives, and so on, while the programs of many of the other committees that met, such as those on lubrication, mechanical springs, strength of gear teeth, etc., concern the whole broad field of mechanical engineering. Statistics are always of interest, and when fairly presented are indicative of the trend of the times. In this connection certain figures relating to A.S.M.E. research-committee activities at the Annual Meeting are illuminating. The 14 committees which met drew a total attendance of 175 persons. In addition five of these committees held open sessions for discussion of their re-

ports and related papers, attracting an average of well over 100 persons at each session.

The growth of A.S.M.E. research activities is due in no small degree to the vision, enthusiasm, and energy of one man—R. J. S. Pigott—who, after fourteen years as a member of the Main Research Committee and the past five years as its chairman, retired from active membership this year. In recognition of his conspicuous service to the Society in the field of research he was presented with an engraved testimonial at the dinner meeting of the Main Committee Thursday evening, December 6, by his various associates during the period of his membership.

Each Annual Meeting records a step forward in the extension of the Society's research efforts into broader fields. Speaking before the Conference of Local Sections Delegates, Chairman Pigott outlined three proposals from the Main Research Committee which, if followed, will contribute materially to the broadening of Local Sections' activities and the increased effectiveness of the Society in the field of cooperative research. These proposals call for the formation of research survey groups in certain Local Sections, joint sessions with trade associations and technical societies meeting in Local Section areas for discussion of pertinent Special Research Committee reports, and the building up of closer relations between local engineering colleges and A.S.M.E. research activities.

Under the leadership of Prof. Albert E. White, Director of the Department of Engineering Research, University of Michigan, and the new chairman of the Main Research Committee, the Society may look forward confidently to increased and useful activity in the field of cooperative engineering research—a field which it is in a unique position to develop.

Book Reviews and Library Notes

THE Library is a cooperative activity of the A.S.C.E., the A.I.M.E., the A.S.M.E. and the A.I.E.E. It is administered by the United Engineering Society as a public reference library of engineering and the allied sciences. It contains 150,000 volumes and pamphlets and receives currently most of the important periodicals in its field. It is housed in the Engineering Societies Building, 29 West 39th St., New York, N. Y. In order to place its resources at the disposal of those unable to visit it in person, the Library is prepared to furnish lists of references on engineering subjects, copies of translations of articles, and similar assistance. Charges sufficient to cover the cost of this work are made.

The Library maintains a collection of modern technical books which may be rented by members residing in North America. A rental of five cents a day, plus transportation, is charged. In asking for information, letters should be made as definite as possible, so that the investigator may understand clearly what is desired.

Practical Industrial-Furnace Design

REVIEWED BY J. D. KELLER[1]

PRACTICAL INDUSTRIAL FURNACE DESIGN. By Matthew H. Mawhinney (Mem. A.S.M.E.). John Wiley & Sons, Inc., New York, 1928. Cloth, 318 pp., 28 tables, 104 illus., $4.

IN A FIELD which is so important to industry, and which has of late years seen such wide development as that of industrial furnaces, it has always seemed surprising that so few treatises on the subject were available. The present publication is therefore timely, and fills a distinct want.

The subject is developed along a somewhat different course from that of heretofore existing treatises on the industrial furnace. The present volume is evidently intended for those who must select and supervise the installation of industrial heating equipment, furnaces, and fuel systems, as well as for designers of furnaces who must reach decisions and complete their designs quickly, and who have not time available for making extended theoretical calculations in connection therewith.

The book strikes a happy mean between the handbook, which gives quickly applicable rules of thumb based on precedent but makes no distinction between cases, and the highly theoretical treatise in which principles universally applicable are given, necessarily with omission of specific rules, and in which, furthermore, the tendency arises to overemphasize some one factor in furnace design at the expenses of others of equal or greater importance. In the present volume, theory is carried as far as is acceptable to the average engineer; thereafter, rules derived from practice are formulated and applied.

"Practical Industrial Furnace Design" is, in a sense, a companion treatise or supplement to Professor Trink's "Industrial Furnaces." Much of the theory given in Vols. I and II of that work is not repeated here, but is assumed as a background.

After the introductory chapter, in which a brief historical review of furnace development is given, follow four chapters on selection of fuels, their characteristics and comparative costs; types of burners, fuel-handling and preparation systems, with calculation of size; on methods of heat application and furnace types embodying them; relation of types to temperature, range and kind of heating to be done, and furnace capacities, with examples of calculation; on methods of handling material inside the furnace as well as to and from it, mechanisms employed, and principles of selection; on fuel consumption and heat-saving methods, with discussion of heat losses from various causes; and an exhaustive compilation of practical average values for fuel consumption of various types of furnaces.

Then follow what are probably the two most important chapters in the book. Chapter VI treats of refractory design and construction, including dimensional layout, size, and location of flues and burner openings, available shapes and sizes of refractories, and properties of refractory materials, together with design and methods of construction of arches, ports, walls, hearths, and foundations. Those who are accustomed to designing only machine parts, where the material can be cast in any form desired, may be unable to appreciate the extent to which furnace design, dealing with structures which must be built up of small discrete pieces, held together somewhat precariously by gravity, friction, and in general by compressive forces only, is and necessarily must be influenced not only by the strength and thermal characteristics of the material but by the mere dimensions and shape of the refractory parts which are available. The furnace designer, however, is fully cognizant of it, and will welcome the

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information here presented. The chapter includes, in addition, a discussion of the methods and the economics of insulation.

Chapter VII deals with the design of metal parts of the furnace proper, including door raisers and pushers, and also discusses the design of auxiliary equipment such as oil and gas burners and piping systems.

Chapter VIII treats of temperature measurement and control; pyrometer types and location; control mechanisms for temperature, atmosphere, and pressure; and the economics of automatic equipment.

The final chapter is devoted to examples of calculations relating to furnaces and auxiliaries, such as size of stacks; burner and piping sizes for air and gas; radiation from openings; best height of furnace chamber; comparative fuel economy of two different furnace types proposed for the same work; salt-bath furnaces; and size or capacity of oil heaters.

One commendable feature of the book is that it presents chiefly original material and practices *selection* in the case of previously published data, in marked contrast to the indiscriminate compilations so often put forth.

The captious critic will, of course, make haste to point out that historical treatment is of a more or less stereotyped form, omitting all mention (for instance) of the notes on furnace construction of Benvenuto Cellini and those of Biringoccio, confining itself to iron and steel heating and ignoring ceramic or glass furnaces; that the combination of wall-conductivity losses (proportional to time) with heat-storage losses (independent of time) is an addition of incommensurables; and that powdered coal and its equipment received scant consideration.

These weak points are offset by the practicality of the treatment throughout, and its adaptation to the wants of the average furnace engineer.

The book will doubtless take its place as one of the standard works on the subject with which it deals.

Books Received in the Library

AERIAL PHOTOGRAPHY; A Comprehensive Survey of Its Practice and Development. By Clarence Winchester and F. L. Wills. Boston, American Photographic Publishing Co., 1928. Cloth, 8 × 10 in., 236 pp., illus., plates, $10.

Contains a wealth of practical information upon aerial photography which will be decidedly useful to all those interested. The material and apparatus now available are described in detail, the authors giving the results of their wide experience. In the final section the applications of aerial photography to surveying, mapping, archaeology, and other sciences are indicated.

BIBLIOGRAPHY, Practical, Enumerative, Historical. By Henry Bartlett Van Hoesen and Frank Keller Walter. Charles Scribner's Sons, New York, 1928. Cloth, 6 × 9 in., 519 pp., $7.50.

This book is intended as a guide to the graduate student and others who have occasion to make serious use of libraries and who wish instruction upon the most advantageous ways of determining what is available in any field, what are the authoritative books, and how literary research should be conducted. The manual is encyclopedic in scope and consequently can treat only of fundamentals, but this breadth has advantages as an introduction to the subject, and certain sections will interest every specialist.

BILDUNGSWERTE DER TECHNIK. By Hermann Weinreich. V.D.I. Verlag, Berlin, 1928. Cloth, 6 × 8 in., 151 pp., illus., 7 r.m.

An able argument for the educational value of technical training. The author discusses current misconceptions concerning the relative importance of scientific and humanistic studies, calls attention to the contributions of technology to civilization and culture, and discusses its place in general education.

CONSTRUCTION OF ALIGNMENT CHARTS. By George W. Swett. John Wiley & Sons, New York, 1928. Cloth, 6 × 8 in., 92 pp., $2.

An elementary text that aims to give a workable knowledge of the subject to students whose mathematical knowledge is limited to ordinary algebra, geometry, and trigonometry. The instruction is clear and simple, and sufficient to enable the user to construct charts for equations of various forms frequently used in engineering.

L'ELECTROCHIMIE ET L'ELECTROMETALLURGIE. By Albert Levasseur. Third edition. Dunod, Paris, 1928. Paper, 7 × 10 in., 361 pp., diagram, 73 fr.

Discusses the theory of electrolysis and of the electric furnace, together with a number of their important industrial applications. The work gives a clear outline of principles and a considerable amount of practical information within moderate compass, and is designed for use both by students and engineers. This new edition is considerably enlarged, especially with respect to the electric furnace.

ENAMELS; Their Manufacture and Application to Iron and Steel Ware. By Laurence R. Mernagh. Charles Griffin & Co., London; J. B. Lippincott Co., Philadelphia, 1928. Cloth, 6 × 9 in., 234 pp., illus., tables, $7.

Contents: The steel blank; general properties of enamels; raw materials used in frit making; clay and other mill additions; tin oxide and its substitutes; calculation of batch formulas and physical properties of enamels; preparation of the enamel; ground-coat enamel; cover coats, white and color; furnaces and fusing equipment; cast-iron enameling; factory layout.

This is a welcome contribution to the scanty literature upon an important industry. The author discusses the manufacture of enameled iron and steel ware from the practical point of view, his book being intended for the manufacturer of commercial enameled articles. Although the work is intended to apply to conditions in Great Britain, the greater part is equally applicable to American works.

THE ENGINEER: His Work and His Education. By Robert Lemuel Sackett. Ginn & Co., Boston and New York, 1928. Cloth, 6 × 8 in., 196 pp., illus., graphs, portraits, $1.40.

Written for the guidance of young men who are thinking of choosing engineering for their life work. The author discusses the aptitudes and abilities that the engineer should have, the financial rewards of the engineer, and the education given him at college. Various branches of engineering practice are analyzed, to assist in the selection of the most suitable one. An appendix contains brief biographies of a few famous engineers. Dean Sackett gives sound information which should be helpful to students in high schools and junior colleges.

IMPURITIES IN METALS; Their Influence on Structure and Properties. By Colin J. Smithells. John Wiley & Sons, New York, 1928. Cloth, 7 × 10 in., 157 pp., illus., diagrams, tables, $5.

Dr. Smithells has collected the available information upon the effects of small amounts of elements upon the structure, mechanical and electrical properties, and corrosion of metals, and presents it here in a systematic manner. The effect of constituents present in concentrations below one per cent, whether present intentionally or as impurities, is considered.

In view of the growing appreciation of the influence of minor constituents upon the properties of metals, this review of our knowledge will be welcome to metallurgists.

THE ENGINEERING INDEX

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THE ENGINEERING INDEX furnishes a Weekly Card Index Service of references to the periodical literature of the world covering every phase of engineering activity, including Aeronautic, Chemical, Civil, Electrical, Management, Mechanical, Mining and Metallurgical, Naval and Marine, Railway, etc. Items of particular interest to mechanical engineers are selected for presentation each month in this Mechanical Engineering Section. In operating The Engineering Index, The American Society of Mechanical Engineers makes available the information contained in some 1700 technical publications received by the Engineering Societies Library (New York), thus bringing the great resources of that library to the entire engineering profession.

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AERIAL PHOTOGRAPHY

Power-Plant Surveys. Aerial Photography in the Power Plant Industry. Power Plant Eng., vol. 32, no. 22, Nov. 15, 1928, pp. 1188–1191, 7 figs. Successfully applied to preliminary surveys of power-plant sites and transmission line location; cameras have been developed for this service; map as small as 1 in. equal 2000 ft. are possible; uneven country causes some distortion on flat plate.

AERODYNAMICS

Research. Present Problems of Aerodynamics (Gegenwartsfragen der Aerodynamik), H. Blenk. V.D.I. Zeit. (Berlin), vol. 72, no. 40, Oct. 6, 1928, pp. 1395–1401, 14 figs. Author reviews results of recent research on airfoils; distribution of pressure on wings; aerodynamics of airfoils at speeds greater than velocity of sound; vibration phenomena, such as wing flutter, etc. Bibliographic lists of works in German and in English.

AIR EJECTORS

Steam-Jet. Steam-Jet Air Ejectors for High Vacuum, D. G. McNair. Mech. World (Manchester), vol. 84, no. 2177, Sept. 21, 1928, pp. 267–270, 5 figs. Consideration of basic principles involved in application of high-velocity steam jet for entrainment and compression of air and incondensible gases; fundamental principle of steam-jet extraction; steam jet as auxiliary to reciprocating air pump; high-vacuum ejectors; single and two-stage ejector; intercooler or condenser; single nozzle as effective as multiple nozzles; multiple-stage compression.

AIRCRAFT

Noise Elimination. Aircraft Noises, W. H. Sayers. Aeroplane (Lond.), vol. 35, no. 13, Sept. 26, 1928, pp. 533–534 and 536. Consideration of how and why noise causes discomfort and distress and whether and how noises of different types vary in their capacity to produce these effects; airplane noises heard from earth; annoyance to passengers; comparison of thin-winged wire-braced biplane with twin engines in wings, with single-engine cantilever monoplane it is proved that braced biplanes are not satisfactory commercial passenger carriers.

AIRCRAFT ENGINES

Air Cooling. Designs and Experimental Studies for Controlling the Heat and Increasing the Efficiency of Air-Cooled Aircraft Engines (Rechnerische und experimentelle Untersuchungen ueber Waermebeherrschung und Leistungssteigerung in luftgekuehlten Flugmotorenzylindern), F. Gosslau. Zeit. fuer Flugtechnik und Motorluftschiffahrt (Berlin), vol. 19, no. 19–20, Oct. 7, 1928, pp. 461–466, 26 figs. Results of theoretical and experimental studies at Siemens and Halske aeronautical research laboratory, indicating defects in design of aircraft-engine cylinders.

Design and Construction. Aircraft Engines (Flugmotoren), F. Gosslau. V.D.I. Zeit. (Berlin), vol. 72, no. 40, Oct. 6, 1928, pp. 1417–1425, 25 figs. General review of progress in design and construction since 1903; modern types of radial, V and W 9-cylinder, 12-cylinder and 18-cylinder engines up to 1000 hp.; water cooling being successfully superseded by air cooling.

Ignition. Airplane Engine Ignition, A. H. Packer. Aviation, vol. 25, no. 19, Nov. 3, 1928, pp. 1408 and 1432 and 1434, 3 figs. Advantages of both battery and magneto ignition systems for airplane engines; high-tension magneto superior as regards reliability; battery ignition has advantage from standpoint of locating trouble on plane; magneto cannot be readily tested without removing from engine; battery ignition has easy starting without auxiliary devices; drawbacks of starting; question of cost; even with superchargers it is doubtful if higher spark voltages will be needed.

Oil Engines. Oil Engines for Aircraft and Railways, A. E. L. Chorlton. Engineering (Lond.), vol. 126, no. 3273, Oct. 5, 1928, pp. 440–443, 15 figs. Application of quick-running oil engine to railway service; it is used as power unit for rail cars, motor trains, and full-sized locomotives; fundamental problems in multi-cylinder, high-pressure, quick-running oil-engine design; supercharging, or two-stage compression, is receiving more attention, and scavenging is being re-introduced. Paper read before Brit. Assn.

The Determination of Several Spray Characteristics of a High-Speed Oil Engine Injection System With an Oscilloscope, C. W. Hicks and C. S. Moore. Nat. Advisory Committee for Aeronautics—Technical Note, no. 298, Sept. 1928, 11 pp., 5 figs. Investigation to determine injection lag, duration of injection, and spray start and cut-off characteristics of fuel-injection system operated on engine and injecting fuel into atmosphere; injection lag in crank degrees decreased with increase of engine speed at constant fuel quantity, but remained constant for variable fuel quantities injected at constant speed.

Reduction Gear. Lorrain Develops Own Reducing Gear for Aircraft Engines. Automotive Industries, vol. 59, no. 12, Sept. 22, 1928, pp. 418–419, 1 fig. Description of reducing gear of planetary type for aircraft engines which has been developed by Société Lorraine of Argenteuil, France, and which, in addition to being used on aircraft engines of that company, is also fitted by Armstrong-Siddeley Co. in England; with reduction ratio of 1.545:1, engine speed of 1900 r.p.m. corresponds to propeller speed of 1230 r.p.m.

AIRPLANE PROPELLERS

Thrust Calculation. Airplane Propeller Thrust, C. W. Rauch. Aviation Eng., vol. 1, no. 1, Oct. 1928, pp. 13 and 19, 1 fig. Selection of ball thrust bearings for aircraft engines; thrust formulas derived from those used in boat-propeller calculations of great aid; formula for propeller thrust in climb; tentative table of ball bearings to be used with different horsepower motors.

Variable-Pitch. The Hele-Shaw-Beacham Variable Pitch Airscrew. Aeroplane (Lond.), vol. 35, no. 15, Oct. 10, 1928, p. 602. Results of tests with variable-pitch propeller on Gloster Grebe with Bristol Jupiter VI engine; under flying conditions control gear showed no noticeable time lag, and engine r.p.m. varied with movement of control practically instantaneously.

AIRPLANES

Autogiro. The Cierva Type C. 17 Autogiro. Aeroplane (Lond.), vol. 35, no. 18, Oct. 31, 1928, p. 746. Few details of Autogiro which is Avro Avian fitted with four-bladed Autogiro 33-ft. 3 1/4-in. diam. windmill, undercarriage of widened track, and small lower wing carrying ailerons.

Design Stresses. Design Stresses, C. D. Holland. Flight (Lond.), vol. 20, no. 39, Sept. 27, 1928 (Aircraft Eng. Supp.), pp. 834d–834e. Load factor and design stresses of materials of construction are defined and discussed; reliability of material; disadvantages in use of yield-point stress as suitable design stress; stress produced under normal maneuvers shall not exceed yield (or proof) stress.

Magnus Effect. Magnus Force Applied to Airplanes, A. A. Kucher. Aviation Eng., vol. 1, no. 1, Oct. 1928, pp. 7–8, 5 figs. Principles and

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NOTE.—The abbreviations used in indexing are as follows:

Academy (Acad.)
American (Am.)
Associated (Assoc.)
Association (Assn.)
Bulletin (Bul.)
Bureau (Bur.)
Canadian (Can.)
Chemical or Chemistry (Chem.)
Electrical or Electric (Elec.)
Electrician (Elecn.)
Engineer (Engr.[s])
Engineering (Eng.)
Gazette (Gaz.)
General (Gen.)
Geological (Geol.)
Heating (Heat.)
Industrial (Indus.)
Institute (Inst.)
Institution (Instn.)
International (Int.)
Journal (Jl.)
London (Lond.)
Machinery (Machy.)
Machinist (Mach.)
Magazine (Mag.)
Marine (Mar.)
Materials (Matls.)
Mechanical (Mech.)
Metallurgical (Met.)
Mining (Min.)
Municipal (Mun.)
National (Nat.)
New England (N. E.)
Proceedings (Proc.)
Record (Rec.)
Refrigerating (Refrig.)
Review (Rev.)
Railway (Ry.)
Scientific or Science (Sci.)
Society (Soc.)
State names (Ill., Minn., etc.)
Supplement (Supp.)
Transactions (Trans.)
United States (U. S.)
Ventilating (Vent.)
Western (West.)

factors of forces created by relatively cylindrical rotating members in path of fluid flow are discussed; applications of Flettner and Savonius rotors to aircraft; number of wings giving greatest torsional power and Magnus pressure found to be two; wing rotors compared with airplane wing; lift reactions.

Polar Diagrams. Experimental Determination of the Polar Diagram of an Airplane and of a Bird in Flight (Sur une détermination expérimentale de la polaire d'un avion et d'un oiseau en vol), E. Huguenard, A. Magnan and A. Sainte-Lague. Académie des Sciences—Comptes Rendus (Paris), vol. 187, no. 14, Oct. 1, 1928, pp. 559–561, 2 figs. Describes method of obtaining polar diagram for pursuit plane from various trajectories of varying slope without wind and propeller at rest; use of moving film.

Structural Design. Recent Problems in Structural Design of Airplanes (Neuere Festigkeitsfragen im Flugzeugbau), K. H. Ruehl. V.D.I. Zeit. (Berlin), vol. 72, no. 40, Oct. 6, 1928, pp. 1403–1408, 17 figs. Review of recent progress, discussing load factors, calculation of vibrations and air-propeller stresses, statics of metallic parts, factors of safety, and materials of construction.

Wings. Measurements of Airfoil Resistance in Flight (Profilwiderstandmessungen im Fluge), M. Schrenk. V.D.I. Zeit. (Berlin), vol. 72, no. 40, Oct. 6, 1928, p. 1402, 3 figs. Abstract of paper "Ueber Profilwiderstands-Messung in Fluge Nach dem Impulsverfahren," published in report of German aeronautic experiment station; resistance of plywood wings of Junkers plane treated with various coatings.

Wings, Movable. The Movable-Wing Biplane, A. Merrill. West. Flying, vol. 4, no. 10, Oct. 1928, pp. 49 and 64, 2 figs. Merrill CIT9 biplane is described by its designer; pitch control is obtained by altering angle of biplane cellule relative to fuselage; opinion expressed that elevator-control ship is properly designed for acrobatic work but badly designed for safe commercial flying; absence of stabilizer; fallacy of idea that longitudinal stability is dependent on long fuselage and stabilizer; height of tail from ground.

AIRSHIPS

Zeppelin. The "Graf Zeppelin." Aviation, vol. 25, no. 17, Oct. 20, 1928, pp. 1261 and 1275–1276, 3 figs. New German dirigible is largest ever constructed, having overall length of 778 ft. and maximum diameter of 100 ft.; hull structure described; accommodations for passengers and navigating and control cabins are provided in main, or forward gondola, which is rigidly attached to keel framing; radio equipment; five specially developed Maybach-Zeppelin VL-2 12-cylinder water-cooled Vee-type engines, each developing 550 hp.; gaseous fuel and fuel lines discussed.

ALLOY STEELS

Cutting Qualities. Cutting Qualities of an Alloy Steel as Influenced by Its Heat Treatment, O. W. Boston and M. N. Landis. Am. Soc. Steel Treating—Preprint, No. 7, for mtg. Oct. 8–12, 1928, 18 pp., 35 figs. Estimating machinability rating of S.A.E. 6140 steel under various heat treatments; cutting rating as influenced by tool life and finish secured; torque and thrust of 1/4-in. drill as measured on drill dynamometer; time of 1/4-in. drill to penetrate 1/4 in.; pure annealing does not give best machining qualities; steels cut best when spheroidizing is greatest. See Abstract in Am. Mach., vol. 69, no. 16, pp. 624–625.

ALLOYS

Copper-Tin. See COPPER-TIN ALLOYS.

Heat-Resisting. Heat-Resistant Alloys. Am. Mach., vol. 69, no. 14, Oct. 4, 1928, p. 551. Composition, properties, and applications of certain heat-resisting alloys are discussed, and include Atha's 2600 alloy, nichromè, ascoloy, and Delhi rustless iron; heat-resistant alloys are in general based on nickel and chromium, but may contain amounts of iron up to 60 per cent or more.

AUTOMOBILE ENGINES

Camshafts, Machining. Reo Camshaft Machining Practice Has Interesting Features. Automotive Industries, vol. 59, no. 14, Oct. 6, 1928, pp. 490–491, 5 figs. Particular machines used and sequence of operations differ somewhat from means customarily employed; production routing and machines are described.

Camshafts, Overhead-Drive. A New Overhead Camshaft Drive. Automobile Engr. (Lond.), vol. 18, no. 246, Oct. 1928, pp. 382–383, 3 figs. Defects in some mechanisms for overhead camshaft drives discussed; new mechanism called Inshaw drive is described in detail; mechanism consists of vertical shaft provided at one end with trunion which engages crankpin attached to driving member; connection is such that it will cause shaft to both reciprocate and oscillate along and about its axis.

Combustion Chambers, Design. Engine Detonation Attributed to High Temperature Attained by Residual Unburnt Gas, R. N. Janeway. Automotive Industries, vol. 59, no. 19, Nov. 10, 1928, pp. 662–666, 8 figs. Most effective means of reducing detonation, in connection with chamber design, is to locate last gas to burn in narrow space of high surface-to-volume ratio; closeness of clearance for maximum results given; best plug location for anti-knock effect is at center of volume; and exhaust valve is favored rather than intake; in offset type most important factor in chamber form, is shape of wall adjacent to clearance space.

Cylinder Blocks, Machining. Same Reamer Used to Machine All Bores in Cadillac Cylinder Blocks, K. W. Stillman. Automotive Industries, vol. 59, no. 17, Oct. 27, 1928, pp. 590–591, 4 figs. Number of interesting operations, employing tools and fixtures not generally used for this work, found in cylinder-block department of Cadillac Motor Car Co., are described; uniform size of bore is obtained, which makes it possible to perform more accurate honing operation.

Pistons, Design. Pistons and Oil-Trapping Rings for Maintaining an Oil Seal, H. M. Bramberry. Soc. Automotive Engrs.—Jl., vol. 23, no. 5, Nov. 1928, pp. 495–498, 7 figs. Provision is made, in piston and rings for adequate flow of heat from all parts of piston head to cylinder wall by means of adequate cross-section of aluminum alloy in head and tongue-and-groove type of piston-ring structure; labyrinth oil seals aids heat transference and prevents leakage past piston rings; heat does not destroy oil seal; most suitable skirt construction.

Pistons, Grinding. Production Grinding of Pistons and Piston Pins. Abrasive Industry, vol. 9, no. 11, Nov. 1928, pp. 296–298, 6 figs. Article describes briefly some of up-to-date grinding operations followed in production; of pistons; mounting piston for grinding; wheels are operated at approximate principal travel of 6000 ft. per min.; piston pins are ground on centerless machines; piston-pin lapping machine.

Valve Springs. Designing the Dual Valve-Spring, A. Moorhouse and W. R. Griswold. Soc. Automotive Engrs.—Jl., vol. 23, no. 6, Nov. 1928, pp. 461–469, 11 figs. Development of Packard dual valve springs by rational analysis combined with experimental verification discussed; analysis of dynamics of valve mechanism; theory of vibration; previous theories inadequate; harmonic analysis; wave theory; conditions of resonance; concentric springs disappointing: mathematical design of spring; construction and assembly of dual valve springs.

AUTOMOBILES

Bearings, Roller. Conical Roller Bearings with Automatic Adjustment (Automatisch sich einstellende Kegelrollenlager), E. Schelle. Motorwagen (Berlin), vol. 31, no. 27, Sept. 20, 1928, pp. 649–650, 6 figs. Details of arrangement patented by F. Hollmann, Wetzlar, Germany, for automatic adjustment of automobile roller bearings.

Bodies, Manufacture. Die Forming in Mass Production of Modern Automobiles (Die spanlose Formung bei der Massenfertigung im nuezeitlichen Kraftwagenbau), O. Kuehner. Maschinenbau (Berlin), vol. 17, no. 7, Sept. 6, 1928, pp. 797–801, 17 figs. Description of special dies and presses used in manufacturing of parts of automobile bodies.

Bodies, Welding. Mass Production Welding Operations, J. W. Meadowcroft. Iron Age, vol. 122, no. 19, Nov. 8, 1928, pp. 1154–1156, 6 figs. Methods of welding automobile bodies oblique welder prevents surface markings; flash welder eliminates hand labor; portable welders simplify jigs; trolley conveyor guarantees steady production; obstacles encountered in welding line overcome. Extracts from address before Am. Welding Soc.

Gears and Gearing, Manufacture. New Forging Method Improves Grain of Ring Gear Blanks, A. F. Denham. Automotive Industries, vol. 59, no. 14, Oct. 5, 1928, pp. 472–474, 6 figs. Dodge practice of upsetting bar stock gives uniform grain structure which makes for better machining and wearing qualities and lessens distortion from heat treating; scrap reduced to minimum.

Shimmying, Prevention of. Independently Sprung Front Wheels, D. S. de Lavaud. Soc. Automotive Engrs.—Jl., vol. 23, no. 4, Oct. 1928, pp. 385–390. Discussion of paper printed in June issue of magazine; brief abstract is given; shimmy frequently occurred when wheels were in synchronism with natural torsional frequency of frame and body; with steering tie rod removed, same shimmy effect was obtainable as with tie rod in place; shimmy and tramp were completely eliminated if steering gear was bolted to axle and connected rigidly to steering-knuckle arms.

Shock Absorbers. Spring Shackles Eliminated by New Hydraulic Shock Absorber. Automotive Industries, vol. 59, no. 15, Oct. 13, 1928, pp. 530–531, 2 figs. Device offered by Baker Wheel Co. as original equipment also serves as bumper bracket; plunger piston attached to spring horns; unit consists of nine parts and is assembled on car in place of spring shackle.

Landis Shock Diffuser. Automotive Industries, vol. 59, no. 12, Sept. 22, 1928, p. 403, 1 fig. Details of shock diffuser of one-way type which uses rigid connecting link between operating arm and axle and is also featured by adjustable bypass; recoil control characteristics can be varied to suit all types of springs and car weights.

AUTOMOTIVE FUELS

Anti-Knock Compounds. Lead Oleate Suggested for Anti-Detonating Fuel, R. Ariano. Automotive Industries, vol. 59, no. 10, Sept. 8, 1928, p. 333. Some notes on recent Continental work on anti-detonating fuels; Prof. G. Ferreri of First Research Department has suggested use of metallic naphthenates and also directed attention to lead oleate; results of various tests. Part of article in Engineering (Lond.), abstracted from Giornale de Chimi Industrielle ed Applicata.

AVIATION

Altitude Flying. Problems of Altitude Flying (Probleme des Hoehenfluges), M. Schrenk. Zeit. fuer Flugtechnik und Motorluftschiffahrt (Berlin), vol. 19, no. 19–20, Oct. 7, 1928, pp. 466–473, 14 figs. Report from German Aeronautical Experiment Station of Aldershof, near Berlin, on purposes and achievements of altitude flying; protection of passengers against effects of high altitude; power and engine problems, use of steam turbines and of rocket engines in altitude flying.

B

BOILER FEEDWATER

Treatment. Modern Practice in Boiler Feed-Water Purification, G. E. Foxwell. Gas World (Lond.), vol. 89, no. 2300, Sept. 1, 1928, pp. 102–106. Author brings before coking industry certain of newer ideas on subject of boiler efficiency as exemplified by modern boiler practice; normal constituent of feedwater; corrosive influence of iron salts; time required for settling of precipitates; Kestner process; influence of oxygen; preventive methods.

BOILER FURNACES

Combustion Control. Automatic Combustion Control for Boiler Furnaces. Power Engr. (Lond.), vol. 23, no. 271, Oct. 1928, pp. 393–398, 12 figs. Details of Roucka system, which is largely development of inventor's multimeter apparatus for facilitating scientific operation of boilers by hand; it comprises three main groups of apparatus for control of rate of combustion, furnace pressure, and fuel-air ratio, respectively.

BOILER PLATES

Temperature Effect. Strength Testing of Boiler Plate at Elevated Temperature (Festigkeitspruefungen an Kesselblechen bei erhoehten Temperaturen), A. Pomp. Zeit. des Bayerischen Revisions-Vereins (Munich), vol. 32, nos. 18 and 19, Sept. 30 and Oct. 15, 1928, pp. 245–248, and 260–263, 7 figs. Notes on elongation, contraction, endurance, notch hardness.

BOILERS

Drums, Forge-Welded. Forge-Welded Boiler Drums Used in Europe, J. M. Brennan. Power, vol. 68, no. 16, Oct. 16, 1928, pp. 643, 1 fig. Details of European methods applied to manufacture of forge-welded drums; Thyssen Works at Muelheim Ruhr, Germany, has rolling mills capable of dealing with ingots weighing 30 tons and can roll to width of 14 ft.; advantages claimed for this type of boiler drum are summarized.

Heating, Manufacture of. Heavy Boiler Sections Are Made on a Production Basis, E. Bremer. Foundry, vol. 56, no. 21, Nov. 1, 1928, pp. 881–884 and 897, 10 figs. Production system as applied to manufacture of boiler sections in Bond Plant of American Radiator Co.; gravity roller conveyors carry finished folds and hoist is used to return empty flasks to machines; molding sand for all molding units made synthetically; rapid system of charging; metal transported from cupolas in ladles holding 800 lb., by electrically operated crane; automatic grinding.

High-Pressure. Practical Drumless Boiler May Be Developed, D. S. Jacobus. Power Plant Eng., vol. 32, no. 20, Oct. 15, 1928, pp.

1087–1088, 2 figs. Series boiler was one step in development of Calumet boiler and use of higher pressures led Babcock and Wilcox Co. to make experiments in drumless boiler provided with forced circulation; series boiler is name given to first of this type tested which had no steam and no water drums; boilers were arranged to have comparatively no frictional resistance to flow of steam and water. Abstract of address before Engrs. Soc. West. Pa.

Locomotive. See LOCOMOTIVE BOILERS.

Water-Tube. Forced Blast Chain Grate Stoker Tests of Marine Water Tube Boiler, T. B. Stillman. Soc. Naval Arch. and Mar. Engrs.—advance paper, no. 9, for mtg. Nov. 15–16, 1928, 5 pp., 4 supp. plates. Paper is devoted to description of tests run with forced-blast chain-grate stoker installed under boiler at Bayonne Works of Babcock and Wilcox Co.; description of tests; efficiency; size of coal to be used.

Water-Tube Boiler at H. M. Dockyard, Portsmouth. Engineering (Lond.), vol. 126, no. 3273, Oct. 5, 1928, p. 444, 2 figs. Details of installation which consists of six units constructed under British Admiralty Survey and to their approval; each unit comprises boiler and superheater having two mechanical chain-grate stokers, and with superimposed economizer in series; economizer is Green's cast-iron horizontal tri-tube type.

BOLTS AND NUTS

Manufacture. Making of Bolts on a Large Scale, G. A. Richardson. Iron Age, vol. 122, no. 19, Nov. 8, 1928, pp. 1157–1160, 6 figs. Methods employed for mass production at Lebanon, Pa., plant of Bethlehem Steel Co. are further described; steps taken in finishing bolts; work in hot-bolt department hand fed; drop-in die forging machines with three dies mounted one above other; work in cold-bolt department carried on entirely with automatic machines; miscellaneous work done in threading shop; bolts trimmed by automatic machines; semi-automatic and special machines.

Mass Production of Bolts and Nuts, G. A. Richardson. Iron Age, vol. 122, no. 17, Oct. 25, 1928, pp. 1015–1021, 9 figs. Ingenious methods and equipment for large-scale manufacture of bolts and nuts at Lebanon, Pa., plant of Bethlehem Steel Co., where 3000 sizes and types are regularly made and carried in stock; two standards for manufacture of nuts in common use in United States; both wrought iron and steel used; bars cut and inspected for size; hot-nut shop makes 150,000 lb. per day; operations in cold-nut department.

C

CABLEWAYS

Marble Quarries. Aerial Ropeway at Carrara, Italy. Engineering (Lond.), vol. 126, no. 3268, Aug. 31, 1928, pp. 260–262, 7 figs. partly on p. 264. Ropeway is built to carry loads of 20 tons, this being heaviest weight so far handled by this means; line has length of 1600 m., and is divided into four spans, longest of which, extending from top terminal to next trestle, is 1150 m.; ropeway consists of two lines of way.

CASE HARDENING

Ammonium Formate. Steel Hardening With Formate Salts (Verstaehlung mittels ameisensaurer Salze), H. Reininger. Maschinenbau (Berlin), vol. 7, no. 18, Sept. 20, 1928, pp. 871–875, 8 figs. Merits of ammonium formate as hardening or steeling agent; ferrous alloys which can be hardened, treatment following hardening microstructure of hardened layers; uses of "steeling" process for hardening of machine parts, etc.; author uses word, Verstealung ("steeling") instead of cementation, as he claims latter expresses only action of carbon, but not that of nitrogen.

Carburizing. On the Energizing Action of Carbonates Contained in Carburizing Mixture, G. Takahashi. Tohoku Imperial Univ.—Science Reports (Sendai, Japan), vol. 17, no. 5, Aug. 1928, pp. 883–926, 28 figs. Velocity of carburization in iron and steel is much more accelerated by use of carburizing agent which consists of mixture of some carbonate and carbon, than in case where carbon alone is used; shows that carburization is due to action of carbonate which sets free carbon from carbon monoxide, nascent carbon atoms diffusing very easily into iron and steel. (In English.)

Nitration. Methods of Approximating Certain Physical Characteristics of Nitrided Steel Cases, G. M. Eaton. Am. Soc. Steel Treating—Preprint, No. 9, for mtg. Oct. 8–12, 1928, 24 pp., 18 figs. Need for inspection testing of nitrided products; vital characteristics of case are hardness and ductility; impressions produced on nitrided case by practically all recognized hardness-testing machines shown by photomicrographs and discussed; Vickers diamond indenter hardness tester gives clearest distinction between brittle and ductile characteristics of nitrided cases. See abstract in Am. Mach., vol. 69, no. 16, p. 627.

CHROMIUM-ALUMINUM STEEL

Properties. An Investigation of the Physical Properties of Certain Chromium-Aluminum Steels, F. B. Lounsberry and W. R. Breeler. Am. Soc. Steel Treating—Advance Paper, No. 23, for mtg., Oct. 8–12, 1928, 31 pp., 13 figs. Physical properties investigated for steel containing as main alloying constituents, aluminum and chromium with silicon and carbon; aluminum effectively stabilized alpha-iron phase and when in combination with chromium, greatly increased resistance of metal to oxidation at elevated temperatures; addition of nickel produced unusual low temperature phenomenon.

COAL

Carbonization, Low-Temperature. Low Temperature Carbonization, D. Brownlie. Eng. and Boiler House Rev. (Lond.), vol. 42, no. 4, Oct. 1928, pp. 195–196, 198 and 200, 3 figs. Some of latest processes in Great Britain are reviewed, including, Bussey, Dvorkovitz, Plassmann, Trumble, Winser and Vandergrift processes.

Low Temperature Carbonization. World Power (Lond.), vol. 10, no. 58, Oct. 1928, pp. 344–352, 4 figs. Reviews papers presented before Fuel Conference in London; and refers particularly to valuable contributions from German authorities; coordination of coal-distillation processes with super-power stations; briquette manufacture; distillation, oil refining, and by-product manufacture by power station; efficient disposal; work of British Fuel Research Board; coal not raw product but basis of production of new products of other industries.

Low-Temperature Carbonization at Dunston Power House, R. P. Sloan. Engineer (Lond.), no. 3796, Oct. 12, 1928, pp. 411–413 and (discussion) 400–401, 8 figs. Plant at station of Newcastle-upon-Tyne Electric Supply Co. is combination of coal-distilling and steam-raising plant and involves submitting coal to two processes; in first, it requires heating to carefully graduated temperature to drive off most of volatile matter to form fluid distillate; in second residue solid distillate must be delivered to boiler furnace and burned therein, substantially as smokeless fuel in form of coke. Abstract of paper read before World Power Fuel Conference.

CONVEYORS

Industrial Plants. Conveyors Lower Labor Costs and Speed Up Production, F. A. Ross. Management, vol. 31, no. 4, Oct. 1928, pp. 41–44. Five years of careful study of all factors involved led Stewart Warner Speedometer Corp. of Chicago, to try out experimental conveyor system which is described; resulting savings in time and labor were so well worthwhile that additional systems were installed.

COPPER-TIN ALLOYS

Transformations. Transformations in Copper Tin Alloys, M. Hansen. Metallurgist (Supp. to Engineer, Lond.), Sept. 28, 1928, pp. 142–143. Author carried out large number of heat treatments on alloys ranging in composition between 12 and 20 per cent tin, time and temperature of annealing and rate of quenching being varied; 580-deg. transformation is not connected with gray violet constituent, but author does not put forward any hypothesis to account for it.

CORES

Binders, Rubber. Rubber Binders for Foundry Cores. Metal Industry (N. Y.), vol. 26, no. 11, Nov. 1928, pp. 470–471. New binders discovered by Bureau of Standards consist of rubber, of balata, or of special commercial type of rubber cement, each dissolved in suitable solvent such as gasoline for plain rubber and benzol for balata and special cement; fire hazards; sand must be free from or very low in, clay content; moisture content of sand; drying molded core; venting and placing cores; plain rubber plus "stiffeners" or "anti-softeners." Abstract of Bureau of Standards—Letter Circular No. 252.

CRANES

Electric-Rotor Handling. Accurate Setting of 258-Ton Rotor Assured. Elec. World, vol. 92, no. 18, Nov. 3, 1928, p. 892, 1 fig. At Conowingo station, Stone and Webster, Inc., built 42-ton structural-steel carrier to facilitate placing 258-ton rotors within their respective stators; carrier was used with two 150-ton electric cranes and was built to allow for universal movement of rotor shaft and assembled coils.

Wharf, Electric. New Level Luffing Electric Jib Crane. Ry. Engr. (Lond.), vol. 49, no. 585, Oct. 1928, p. 382, 2 figs. Photograph and line drawing of new 4-ton portal jib crane for wharfage service; crane is fitted with four 3-phase a.c. slip-ring type motors of varying sizes; designed to lift 3 tons at 27 ft. 6-in. radius and 1 1/2 tons at 55-ft. radius; arranged for high-speed work and special attention has been paid to position of controllers; it is extremely steady in its movements and entirely free from all trace of kick.

CUTTING TOOLS

High-Speed Steel. See HIGH-SPEED STEEL.

Methods of Holding. Methods of Holding Tools and Cutters, F. Horner. Machy. (Lond.), vol. 31, no. 801, Feb. 16, 1928, pp. 641–644, 5 figs. Designs for clutch drives and fastenings, floating joints, and quick-acting couplings are discussed and illustrated.

Tungsten Carbide. Hardest Steels are Machined With New Cutting Tool Material. Automotive Industries, vol. 59, no. 16, Oct. 20, 1928, pp. 560–561, 3 figs. Description of experiments with Carboloy, combination of tungsten carbide and cobalt which cuts glass like diamond and resists wear even when working against such materials as genelite and bakelite; information furnished by General Electric Co.; cuts thread on glass.

Tungsten Carbide—A New Tool Material, S. L. Hoyt. Am. Mach., vol. 69, no. 16, Oct. 18, 1928, pp. 623–624. Results of experiments on tungsten-carbide or Carboloy as tool material, conducted by General Electric Co. in its research laboratory and in its shops; Carboloy is capable of producing well-defined scratch in sapphire; cutting groove on alundum wheel; machining bakelite, cast iron, and nickel steel. Abstract of paper presented before Am. Soc. Steel Treating.

Tungsten Carbide—New Cutting Tool Material—Scratches Sapphire, S. L. Hoyt. Iron Trade Rev., vol. 83, no. 15, Oct. 11, 1928, pp. 912–913, 4 figs. Properties and applications of tungsten carbide for cutting tools are described; study of performance of this material undertaken by General Electric Co.; tools found to be of great assistance in handling many hard, tough and non-machinable steels. Abstract of paper presented before Am. Soc. Steel Treating.

D

DIE CASTING

Metals for. Cooperative Investigations on Die Castings. Iron Age, vol. 122, no. 14, Oct. 4, 1928, p. 814. Review of meeting of Inst. of Metals; High-melting brasses, aluminum-base alloys, and low-melting zinc-base castings studied; high-speed steel dies favored.

Steel for Dies. Die Steels in the Aluminum Die Casting Industry, S. Tour. Min. and Met., vol. 9, no. 261, Sept. 1928, p. 415. When using chrome-vanadium steel for dies in aluminum die-casting industry, 6 years ago, dies were expensive and only lasted average of 20,000 castings; dies for making waffle grids would show cracks after only few thousand; new steels were developed, one containing considerable nickel and others tungsten and chromium; waffle-grid blocks now give 50,000 to 100,000 castings before being replaced. See abstract in Iron Age, vol. 122, no. 15, Oct. 11, 1928, p. 894.

DIES

Bending. Bending Dies for Accurate Work. Machy. (Lond.), vol. 33, no. 838, Nov. 1, 1928, pp. 154–155, 2 figs. Design of bending dies for accurate work is discussed; punch and die for making right angle bends in lock part; details of bending die for very accurate work mounted in pillar press to secure perfect alignment.

Forging, Hardening of. Hardening Drop-Hammer Dies, J. C. Kielman. Am. Mach., vol. 69, no. 17, Oct. 25, 1928, pp. 657–658, 4 figs. Methods and equipment employed by New Departure Manufacturing Co., Bristol, Conn., are described; hundreds of drop-forging dies are hardened in course of year; dies of open-hearth and alloy steels are quenched in water or oil and are drawn to hardness indicated by scleroscope test.

DIESEL ENGINES

Automotive. Improving Upon Diesel-Motor Transport (Lond.), vol. 47, no. 1229, Oct. 1, 1928, pp. 389–390, 6 figs. Acting principle of Airel engine which introduces entirely new thermal cycle is described; single-cylinder experimental unit is 12-hp. 2-cycle engine; 60 mm. bore; 120 mm. stroke; weight 22 1/2-lb.

per hp.; comparison with ordinary Diesel engine; heavy oil fuel used ignition depending on heat of high compression; large capacity combustion chamber with water injection; supercharging air during compression stroke; motor-truck and marine engines proposed.

Compressorless. High-Speed Diesel Engines (Schnellauf bei Dieselmotoren), A. Reinsch. V.D.I. Zeit. (Berlin), vol. 72, no. 39, Sept. 29, 1928, pp. 1371–1375, 14 figs. Paper read at 1928 annual meeting of Society of German Engineers (V.D.I.); general principles and evolution of high-speed compressorless Diesel engines; details of Maybach, Linke-Hofmann, and other German makes; fuel pumps by Bosch and by Deutz, A. G.

High-Speed. High-Speed Diesel Engines, A. E. L. Chorlton. Automotive Industries, vol. 59, no. 15, Oct. 13, 1928, p. 531. For aircraft purposes oil engine must develop brake mean effective pressure of at least 100 lb. per sq. in. and 120 lb. is preferable; test results with 8-cylinder Berdmore engine; experimental engine for use on oil-electric locomotive. Abstract from paper presented before Brit. Assn. for Advancement of Science.

Ignition and Combustion. Ignition and Combustion Phenomena in Diesel Engines, F. Sass. Nat. Advisory Committee for Aeronautics—Technical Memorandum, no. 482, Oct. 1928, 26 pp., 8 figs. Evidence is found that neither gasification nor vaporization of injected fuel occurs before ignition; hydrogen coefficient has no significance; knowledge of ignition point and time lag is important; after ignition, combustion proceeds in series of reactions, last of which, at least, are now known; theories of number of men discussed. From V.D.I. Zeit., Sept. 10, 1927.

Pulverized-Fuel. Burning Powdered Coal in Diesel Engines, H. Schreck. Power, vol. 68, no. 19, Nov. 6, 1928, pp. 748–749, 1 fig. If simplicity of service inherent in Diesel engine and low price of fuel can be combined, answer to far broader application of Diesel engine and cheaper production of power is given; such unit is now being presented by Diesel engine operated on powdered coal; engine, as developed in Germany, has fuel consumption of 0.66 lb. of coal per hr. when operated with coal of 12,600 B.t.u.

The Coal Dust Motor, R. Pawlikowski. Engineer (Lond.), vol. 146, no. 3794, Sept. 28, 1928, p. 353, 2 figs. Discussion on burning of coal dust and other powdered fuels in internal-combustion engine; 40-b.hp. horizontal engine of Deutz pattern and 25-b.hp. 2-cycle hot-bulb engine are being rebuilt for use with powdered coal; fuels which have been tested include anthracite, bituminous coal, charcoal, turf, lignite, rye dust, and blast-furnace coke. Abstract translated from V.D.I. Zeit.

The Coal-Dust Engine, L. H. Morrison. Power, vol. 68, no. 19, Nov. 6, 1928, pp. 746–747, 4 figs. Successful operation of Pawlikowski powdered-coal engine proves that Diesel's original patent on internal-combustion engine was based on sound logic; first Diesel adapted to powdered coal was single-cylinder unit; to this has since been added 3-cylinder unit of 18-hp. capacity; success of engine is due primarily to design of coal-dust fuel valve and to use of small charge of oil to insure ignition.

The Pulverized-Coal Diesel Engine, A. Heller. Eng. Progress (Berlin), vol. 9, no. 10, Oct. 1928, pp. 289–298, 1 fig. Brief account of experiments on single-cylinder, 4-stroke M.A.N. Diesel; when operated with powdered coal it requires only about 2000 kg.-calories (about 8000 B.t.u.) to produce 1 hp-hr. of useful work.

The Rupa Pulverised Fuel Engine. Engineering (Lond.), vol. 126, no. 3272, Sept. 28, 1928, pp. 408–412, 18 figs. Rupa engine has been run on many kinds of pulverized fuel, including hard coal and brown coal, peat, sawdust, charcoal, rice dust, meal and even powdered coke; in addition to 80-hp. Rupa engine described, 40-hp. horizontal engine, 25-hp. vertical hot-bulb engine and 150-hp. 3-cylinder engine have also been changed over from oil to coal propulsion with satisfactory results.

Supercharging. Exhaust Charged Diesel Engines, M. A. Buchi. Gas and Oil Power (Lond.), vol. 24, no. 277, Oct. 4, 1928, pp. 5–6, 2 figs. Method by which exhaust gases from large 4-stroke Diesel engine have been made to drive turbine supercharger is described; this turbine does not do any external work, but only drives supercharger; it is erected quite independently of engine; explanation of 50 per cent increase in output made possible by supercharging at only 3.55 lb. per sq. in. From paper presented to World Power Fuel Conference, London.

Supercharging. Engineering (Lond.), vol. 126, no. 3274, Oct. 12, 1928, p. 462. Editorial comment on Buechi system of supercharging; supercharging to extent of 30 lb. per sq. in. gage has been tried experimentally, and Buechi has expressed hope that this may ultimately be normal figure; in that case normal output would be tripled; maximum pressures are not increased by supercharge, but are merely longer maintained.

DIESEL LOCOMOTIVES

Germany. A New German Diesel Locomotive. Ry. Engr. (Lond.), vol. 49, no. 585, Oct. 1928, pp. 377–379 and 385, 4 figs. Locomotive, built by Berliner Maschinenbau A. G., is equipped with hydraulic transmission and has been undergoing tests on section of German Railways; has 2–4–0 wheel arrangement; propelling machinery comprises vertical single-acting 4-cycle, 6-cylinder Diesel engine, coupled direct with compressor for supplying compressed air for starting and fuel injection; rated capacity of engine is 220 hp. at 450 r.p.m.; principal particulars and dimensions of locomotive are given.

Diesel Locomotive With Hydraulic Drive, K. Vetter. Eng. Progress (Berlin), vol. 9, no. 10, Oct. 1928, pp. 287–289, 4 figs. Berliner Maschinenbau-A.-G. recently completed Diesel locomotive equipped with Schwartzkopff-Huwiler hydraulic transmission unit; built by way of experiment to obtain information as to adaptability to railway service of this type of stepless variable-speed reducer, which has proved very successful in other kinds of service.

DRILLS, TWIST

Investigation of. Experimental Study of Twist Drills (Versuche mit Spiralbohrern), E. Sachsenberg. Maschinenbau (Berlin), vol. 7, no. 19, Oct. 4, 1928, pp. 905–911, 27 figs. Results of experiments, at Dresden Institute of Technology on torque and feed power as functions of spiral pitch, for various speeds and feeds in drilling steel, cast iron, and brass; three-dimensional charts of results; photographs illustrating drilling process.

E

ELECTRIC FURNACES

Arc. Proving the Value of Electric Furnaces for Melting Non-Ferrous Metals. Elec. News (Toronto), vol. 37, no. 20, Oct. 15, 1928, pp. 47–48, 2 figs. Two years' experience with electric brass furnace of Detroit arc type; capacity of 1000 lb. per hr.; source of supply is 550 volts single phase, 25 cycles stepped down to 80 volts; majority of castings produced in this foundry are of pressure type of highest quality and require very accurate control of analysis and pouring temperature; aluminum melting pot; supply is single phase, 25 cycles, and is transformed from 550 volts to 110 volts.

Heat-Treating. Progress Made in the Use of Electric Furnaces for Heat Treating, A. N. Otis. Am. Soc. Steel Treating—Preprint, No. 27, for mtg. Oct. 8–12, 1928, 28 pp., 13 figs. Present status of electric furnaces, extent of their use for heat treating, and some new types that have been recently developed; advantages for heat treating; some of individual furnaces and their operation briefly described; electric furnaces for forging; continuous furnaces for new process of copper brazing, and for annealing in atmospheres of protecting gas. See abstract in Am. Mach., vol. 69, no. 16, pp. 626–627.

Electric Machinery. Standard Line of D.C. Machines Fabricated by Arc Welding, R. S. Martens, C. C. Brinton and F. T. Hague. Am. Welding Soc.—Jl., vol. 7, no. 9, Sept. 1928, pp. 8–20, 8 figs. Development of arc-welded fabricated construction has made it possible to combine contrary requirements of design flexibility and low manufacturing cost by application of standard part idea to electric-machine design; general principles adhered to in development of larger sizes of this line of completely fabricated d.c. machines; special equipment is essential to produce parts; details of few of major parts made clear by sectional view of typical machine.

ELECTRIC WELDING

Developments. Electric Welding. Am. Inst. Elec. Engrs.—Jl., vol. 47, no. 10, Oct. 1928, p. 736. Annual report of Committee on Electric Welding. During past year marked progress has been made in application of electric welding to increasing number of industrial uses, including welding of pipe, pipe lines, structures, and cracking stills for gasoline production; outstanding applications are mentioned by way of example.

ELECTRIC WELDING, ARC

Atomic-Hydrogen. Atomic Hydrogen Welding in Production, P. C. Greene. Iron Age, vol. 122, no. 15, Oct. 11, 1928, pp. 883–884, 3 figs. Applications and advantages of atomic-hydrogen welding are given; ideal combination of high temperature with reducing atmosphere gives unusually strong ductile welds at rapid rate, free from oxides and blowholes, and with smooth finished appearance; gas-tight seams for refrigerators and indicating instruments; strong joints on automobile parts; repairs to dies.

Automatic. Automatic Arc Welding. Elec. News (Toronto), vol. 37, no. 20, Oct. 15, 1928, pp. 49–50, 1 fig. Large number of machines devised for special applications; automatic head capable of uniform work is adapted to many uses; horizontal seam welder; circular seam welder; automatic resistance welding; applications.

Structural Steel. An Interesting Thesis on Structural Arc Welds. Am. Welding Soc.—Jl., vol. 7, no. 9, Sept. 1928, pp. 84–96, 13 figs. Paper gives results of laboratory research on average welding work of local shops; three standard makes of steel, and five brands of $\frac{1}{32}$-in. bare wire electrodes were employed; strain distribution in welded specimens; tests of beams; tests of columns; procedure of tests.

ENERGY

Transmission of. Transmission of Energy, D. W. Smith. World Power (Lond.), vol. 10, no. 58, Oct. 1928, pp. 421–422 and 427–428, 1 fig. Data on costs of transmission; influence of cost of transmission of various forms of energy; paper reviewing transmission, over various distances, of energy in form of coal, coke, oil, gas and electricity; special reference is made to influence of costs of transmission on coal-gas production and electricity generation; cost of energy for domestic purposes in Great Britain. Abstract of paper presented before World Fuel Conference in London.

EYEBOLTS

Stresses in. Stresses in Eyebolts. Machy. (Lond.), vol. 32, no. 832, Sept. 20, 1928, pp. 841–843, 5 figs. Eyebolts tested to destruction by direct pull, generally fail in threaded part of shank; those tested under conditions of considerable slantwise pull often rupture in ring part, and almost without exception distort badly; it is recommended that ring section stresses should at all events be kept well within elastic limit of material.

F

FORGING MACHINES

Universal. High-Efficiency Universal Forging Machine. Machy. (Lond.), vol. 32, no. 832, Sept. 20, 1928, pp. 835–838, 8 figs. Details of Schneider-Emuco universal forging machine with mechanically operated fixed die; forgings produced in fewer blows than is possible on older types; work carried out with gripping slide; material up to 4 in. in diam. or $3\frac{1}{2}$-in. square accommodated; unusual length of upsetting slide; gripping die capacity; mechanical opening of fixed die; crankshaft constructed on massive lines.

FUELS

Calorific Value, Calculation of. The Steuer Formula for Calorific Value (Die Steuersche Heizwertformel), K. d'Huart. Waerme (Berlin), vol. 51, no. 38, Sept. 22, 1928, pp. 685–687. It is shown that this formula gives useful results in calculating heat value of solid fuels.

Coal. See COAL.

Oil. See OIL FUEL.

FURNACES

Electric. See ELECTRIC FURNACES.

Heat-Treating. Furnace Requirements for Mass Production, A. J. Stevenson. Heat Treating and Forging, vol. 14, no. 9, Sept. 1928, pp. 1061–1062, 5 figs. Review of developments in furnace design; increase in output of automobiles has made necessary change in furnace construction to supply parts in sufficient quantity; continuous furnace; moving stock in furnace; furnaces for forging; division of zones in heat-treating furnaces.

G

GAGES

Automatic Gaging Machine. Automatic Machine Gaging, C. W. Robbins. Bell System Tech. Jl., vol. 7, no. 4, Oct. 1928, pp. 708–729,

20 figs. Paper discusses advantages to be gained in certain types of large-scale production by substitution of automatic machine gaging for hand testing; machine will effect saving of $8000 per year over cost of hand gaging on output of 4,500,000 blocks; author points out that in some instances automatic-machine gaging of entire product will cost less than sampling inspection.

Inside Indicator. Inside Indicator Gage. Machy. (Lond.), vol. 33, no. 837, Oct. 25, 1928, p. 115, 1 fig. Description of Johansson inside indicator gages which are made in range of five sizes covering all diameters from 3/8-in. to 6 in., or 9 to 150 mm.

Krupp Mikrotast. Krupp Mikrotast Gages. Instruments, vol. 1, no. 9, Sept. 1928, pp. 421–424, 6 figs. Gage designed by Krupp Steel Works of Germany to fit all external, internal, taper, and thread gages, consists of indicating mechanism of knife-edge type and transmits axial movement of contact rod into swinging movement of pointer.

GEARS

Hardening. The "Shorter" Gear Hardening Process. Machy. Market (Lond.), no. 1458, Oct. 12, 1928, p. 940, 2 figs. Outstanding feature of Shorter process is that instead of heating and hardening whole gear wheel only that portion of tooth required to be hard is heated by oxyacetylene or other high-temperature flame, each tooth being immediately quenched in water as soon as necessary heat has been applied; machine is arranged to take gears of varying sizes.

Lapping. Gear Lapping Facilitated by Manufactured Abrasives, H. J. Willis. Iron Age, vol. 122, no. 16, Oct. 18, 1928, pp. 949–950. No one abrasive is suitable for more than few types of gears; hardened gears having sliding action require hard sharp grain, which, if used on soft gears having rolling action, would prove disastrous; gears having both rolling and sliding action require still different abrasive. Abstract of paper presented before Am. Gear Manufacturers' Assn. and Am. Soc. Mech. Engrs.

Reduction. Gives Comprehensive Data on High-Speed Turbine Gearing, I. Short Iron Age, vol. 122, no. 16, Oct. 18, 1928, pp. 948–949. Data relating to reduction gearing of helical-tooth type furnished by Westinghouse Mfg. Co.; two types of wear said to occur at meshing faces of gear teeth; pitting considered to be in nature of corrective agency; tracing origin of noise emitted from gear. Abstract of paper presented before Am. Gear Manufacturers Assn. and Am. Soc. Mech. Engrs.

Teeth, Shaving. Method of Finishing Gear Teeth by "Shaving" Process Is Developed, H. D. Tanner. Automotive Industries, vol. 59, no. 18, Nov. 3, 1928, pp. 625–627, 12 figs.; also Am. Mach., vol. 69, no. 17, Oct. 25, 1928, pp. 659–661, 11 figs. New gear-manufacturing method, known as gear shaving, in which four cuts are made upon previously rough-hobbed gear by means of cutting tool having slightly concave edge, is described; machine designed by Pratt and Whitney Co. is automatic; process is one of zero-degree generation. Abstract of paper presented before Am. Gear Mfrg. Assn.

GRINDING MACHINES

Thread. Precision Thread Grinding Machine, Abrasive Industry, vol. 9, no. 11, Nov. 1928, pp. 312–314, 3 figs. Société Génévoise new model of high-precision thread-grinding machine, designated as Filor tool for production grinding of thread gages, taps, hardened worms, micrometer screws; grinds on return motion as well as on forward travel normal speed of wheel spindle is 1360 r.p.m. reversal of work spindle is accomplished by double-friction clutch operated by oil pressure; diamond wheel truing and forming device. See also description in Machy. (Lond.), vol. 33, no. 835, Oct. 11, 1928, pp. 53–56, 8 figs.

H

HARDNESS TESTING

Pendulum Instruments. Test With Herbert Pendulum Hardness Tester (Versuche mit dem Herbert-Pendelhaertepruefer bei der Bearbeitung durch spanabhebende Werkzeuge), A. Wallichs and K. Krekeler. Stahl u. Eisen (Duesseldorf), vol. 48, no. 19, May 10, 1928, pp. 626–627, 4 figs. Description of experiments of hardness changes carried out at Technische Hochschule at Aachen; materials tested were used in form of tubes of 4 mm. wall thickness both case-hardening and heat-treated steels were tested; results after machining were not very conclusive. See translated abstract in Metallurgist (Supp. to Engineer, Lond.), Sept. 28, 1928, p. 143.

Machines. Machines for Engineering Experiments and for Testing of Hardness (Maschinen fuer Haertepruefungen, Technologische Versuche und Verschleisspruefungen an metallischen Werkstoffen), W. Deutsch and G. Fiek. V.D.I. Zeit. (Berlin), vol. 72, no. 43, Oct. 27, 1928, pp. 1541–1546, 32 figs. Details of Mohr and Federhaff, Losenhausen, and other makes of machine for testing Brinell and Rockwell hardness; machines for testing cupping property, ductility, and abrasive resistance.

HEAT TRANSMISSION

Pipes. Pipe Resistance and Heat Transfer (Rohrwiderstand und Waermeuebergang), H. Lorenz. Zeit. fuer die gesamte Kaelte-Industrie (Berlin), vol. 35, no. 8, Aug. 1928, pp. 149–154, 7 figs. Paper read at 1928 annual meeting of German Refrigeration Society (Kaelte Verein); theoretical mathematical discussion of resistance to flow and heat transmission in pipes.

HIGH-SPEED STEEL

Hardening. Effect of Hardening Temperatures and Annealing on Cutting Efficiency of High-Speed Steels (Einfluss der Haertetemperatur und des Anlassens auf die Schnittleistung der Schnellarbeitstaehle), E. Kothny. Maschinenbau (Berlin), vol. 7, no. 20, Oct. 18, 1928, pp. 959–966, 45 figs. General review of properties of high-speed steels; comparative tests of cutting capacity of high speed steels tempered at 350 and 590 deg. cent. show advantages of higher-temperature hardening.

Heating High Speed Steel to 2400 Degrees Fahr. in Molten Lead, W. C. Searle. Am. Soc. Steel Treating—Advance Paper, no. 29, for mtg. Oct. 8–12, 1928, 4 pp., 3 figs. Apparatus and method of heating high-speed steel to 2300 to 2400 deg. fahr. in molten lead are described; photomicrograph shows structure obtained in specimens at 2200, 2300, and 2400 deg. fahr.; method of hardening is simple and very satisfactory for moderate production; little danger of destroying delicate edges before tool is heated through.

Heat Treatment. A New Method for Heat Treating High Speed Steel, H. C. Knerr. Am. Soc. Steel Treating—Advance Paper, no. 21, for mtg. Oct. 8–12, 1928, 17 pp., 7 figs. Method described includes electric heating, close temperature control which may be made automatic, use of salt bath which does not give off fumes or attack tools, prolonged container life, absence of furnace deterioration, comfortable working conditions, low heating cost per pound of steel, and ability to employ full hardening temperatures without injury to finished surfaces or cutting edges of high-speed steel tools.

HOLES

Ball Burnishing of. Ball Burnishing of Holes (Press-Finish Process) (Das Aufkugeln von Bohrungen (Pressfinish-Verfahren)), O. Schlippe. Maschinenbau (Berlin), vol. 7, no. 18, Sept. 20, 1928, pp. 862–867, 17 figs. Description of "press finish" process, invented by G. Mattson, which consists of burnishing bored or drilled hole by forcing ball of slightly larger diameter through it; experimental study of process including microscopic study of interior surface of hole and hardness tests.

HYDROELECTRIC DEVELOPMENTS

Ontario. Hydro-Electric Power in Ontario. Engineering (Lond.), vol. 126, no. 3273, Oct. 5, 1928, pp. 418–419. Review of annual report for year ended Oct. 31, 1927, of Hydroelectric Power Commission of Ontario; good progress is being made with supply of electricity in both urban and rural districts; output of 22 hydroelectric stations operated by Commission was 3,904,432,004 kw-hr., while 201,802,454 kw-hr. were purchased.

I

ICE PLANTS

Diesel-Driven. Oil Engine Power Reduces Ice Making Costs. Power Plant Eng., vol. 32, no. 22, Nov. 15, 1928, p. 1192, 2 figs. Ice Cost reduced 73 per cent in Sterling, Ill., plant by substituting oil engine for purchased power; installation of 160-hp. Buckeye twin-cylinder, two-cycle, single-acting, solid-injection, semi-Diesel engine was decided upon; belted to 50-kw., 3-phase, 60-cycle Westinghouse generator.

INDUSTRIAL MANAGEMENT

Measurement of. A Plan for Measuring Management, F. J. Oliver, Jr. Am. Mach., vol. 69, no. 16, Oct. 18, 1928, pp. 601–605, 1 fig. Four major factors, quality, service, cost and personnel control are taken into account; bogies are set, against which actual results are compared to determine efficiency of performance; after two years' use in Westinghouse Lamp Co. factories, plan resulted in marked increase in efficiency and raising of morale; all data used obtained from regular factory records; score board shows progress made since measuring plan was started.

INDUSTRIAL RESEARCH

Value of. Industrial Research Pays Big Returns, L. P. Alford. Mfg. Industries, vol. 17, no. 7, Nov. 1928, pp. 511–515, 6 figs. Practical value of industrial research; real function of research laboratory; principal aim of industrial research is to effect economies in production, to make better, cheaper, more serviceable articles of commerce; scope of functions; problems confronting research; direct and indirect gains.

INSULATING MATERIALS, HEAT

Conductivity. The Determination of Thermal Conductivity at Low Mean Temperatures, C. K. Swift. Am. Soc. Heat. and Vent. Engrs.—Jl., vol. 34, no. 10, Oct. 1928, pp. 755–758, 2 figs. Selection of 60 deg. fahr. as mean temperature at which samples should be tested; experimental procedure requires certain changes in testing equipment; purpose of paper is to describe form of apparatus which has been found suitable for this purpose.

INTERNAL-COMBUSTION ENGINES

Atomization in. Study of Atomization With Vaporizing Atomizer (Untersuchung der Zerstaeubung durch Spritzvergaser), J. Sauter. V.D.I. Zeit. (Berlin), vol. 72, no. 44, Nov. 3, 1928, pp. 1572–1574, 6 figs. Report from laboratory of engineering physics of Munich Institute of Technology on tests of Claudel-Hobson, Zenith, and other atomizers; significance of fineness of spray, measurement of size of average spray particle; discussion of results. Abstracted from Forschungsarbeiten auf dem Gebiete des Ingenieurwesens, no. 312.

Efficiency Determination. Internal Combustion Engine Efficiency and Its Determination by the Aid of a Chart, E. F. Witchell. Engineering (Lond.), vol. 126, no. 3272, Sept. 28, 1928, pp. 412–414, 5 figs. Curve is presented showing value of internal energy, and curves showing effect of adiabatic change in volume; similar charts can be drawn for any mixture of gases of which volumetric composition is known. Paper read before Brit. Assn.

Fuel Injection. A New Process of Feeding Explosion Engines (Sur un nouveau procédé d'alimentation des moteurs à explosion), F. Rochefort. Académie des Sciences—Comptes Rendus (Paris), vol. 187, no. 16, Oct. 15, 1928, pp. 638–640. Author describes method of feeding fuel to explosion engines by means of pulverized gas-oil mixture which utilizes, instead of pure air, carbureted compressed gas furnished by engine itself; system gives remarkable results even in single-cylinder engines.

High-Compression. The "Hult" High Compression Internal Combustion Motor. Engineer (Lond.), vol. 146, no. 3795, Oct. 5, 1928, p. 374, 1 fig. New engine was invented by O. W. Hult, chief engineer of Aktiebolaget Archimedes, of Stockholm; chief feature is subjecting of charging air to considerable cooling before it enters main cylinder, so that higher cylinder compression with consequent increase in efficiency can be obtained; tests have been carried out on twin-cylinder experimental unit.

Ignition. A Study of the Dynamics of Ignition (Untersuchungen zur Dynamik des Zuendvorgangs), O. Kluesener. V.D.I. Zeit. (Berlin), vol. 72, no. 44, Nov. 3, 1928, pp. 1580–1584, 24 figs. Report from department of internal-combustion engines and engineering thermodynamics of Hanover Institute of Technology on experimental study of form of flame, eddying in flaming substance, and propagation of flame.

Valve Springs. Researches on Springs—The Surging of Engine Valve Springs, A. Swan and L. G. Savage. Dept. of Sci. and Indus. Research—Special Report (Lond.), no. 10, 1928, 28 pp., 11 figs. Results of tests to measure surging or wave motion generated by impact between cam and valve; experiments were carried out on 8-cylinder Benz-engine valve gear; apparatus and methods are described and results are analyzed and discussed.

[See also AIRCRAFT ENGINES; AUTOMOBILE ENGINES; DIESEL ENGINES.]

IRON AND STEEL PLANTS

Performance Measurements. Measurements in Modern Iron and Steel Works, Especially in Blast Furnaces and in the Power Plant (Les mesures dans les usines métallurgiques modernes et en particulier aux hauts fourneaux et à la station centrale), L. Persoz. Revue Industrielle

(Paris), vol. 58, no. 2225, Apr. 1928, pp. 201–208, 6 figs. Author shows manner of using measurements and analyses in order to calculate heat balance and efficiency with view to improve operation and lessen cost; efficiency of Cowpers; central-station measurements.

IRON FOUNDRIES

Practice. Effects Savings in Production of Heavy Gray Iron Castings, E. C. Kreutzberg. Foundry, vol. 56, no. 20, Oct. 15, 1928, pp. 842–846 and 859, 7 figs. Iron foundry practice in plant of William Sellers and Co., Philadelphia; large reduction in loss due to defects resulted primarily from changes in sand system and in analysis of iron; to avoid excess of clay, as much old sand as possible is used; making of oil-sand mixtures; cleaning castings; iron analysis; details of equipment in foundry.

L

LIFTING MAGNETS

Iron and Steel Plants. Lifting Magnets in the Iron and Steel Industries, C. H. S. Tupholme. Iron and Steel Industry (Lond.), vol. 2, no. 1, Oct. 1928, pp. 11–13, 3 figs. High-power magnets more economical; construction of circular magnet; precautions against moisture; advantages of rectangular magnets; ease of control possible; direct current is required for excitation of lifting magnets and either 115, 230 or 500 volts is suitable; lifting capacity of magnets.

LIGHTING

Factory. Raising the Level of Artificial Illumination, E. F. Labadie. Indus. Eng., vol. 86, no. 10, Oct. 1928, pp. 524–526, 6 figs. How Fisher Body Co. obtains lighting that approaches ideal for various types of their work; taking up various departments from standpoint of lighting problems encountered; as most of work is in vertical plane, lighting units are hung so as to give best results in this plane; for majority of operations that are necessary in trimming of body, general illumination of 20-foot candles is sufficient.

LOCOMOTIVE BOILERS

Combined Water-Tube and Fire-Tube. Records of Combined Watertube and Firetube Locomotive Boilers. Boiler Maker, vol. 28, no. 10, Oct. 1928, pp. 281–289, 4 figs. Advantages of three types now in service as compared with stay-type boilers; Baldwin Locomotive Works No. 60,000 is described; details of firebox; Baltimore and Ohio Mikado locomotive No. 4045 and class Q-1x; Delaware and Hudson Co. locomotive Horatio Allen; New York, New Haven and Hartford Railroad Co. McClellon-type locomotive boiler; French water-tube locomotive; Brotan boiler; higher steam pressure possible; comparison of locomotives having combined water and fire-tube boilers. Paper presented before Master Boiler Makers Assn.

LOCOMOTIVES

Diesel. See DIESEL LOCOMOTIVES.

4–8–4 Passenger. Passenger Locomotives, 4–8–4 Type, Canadian Pacific Railways. Can. Ry. and Mar. World (Toronto), no. 368, Oct. 1928, pp. 573–575, 3 figs. Largest and most powerful passenger locomotives in British Empire; boiler working pressure of 275 lb. per sq. in use of nickel steel in boilers; cylinder and valve-chest castings are of cast steel; tractive effort developed is 60,800 lb.; with factor of adhesion 4.12; cylinders, diameter and stroke 25½ × 30-in.; weight in working order, total engine 423,000 lb.

Gasoline. Gasoline Locomotives for Industrial Switching, C. Heim. Baldwin Locomotives, vol. 7, no. 2, Oct. 1928, pp. 72–75, 7 figs. Locomotive is powered with Beaver-Le Roi 6-cylinder engine having 6¼-in. bore and 7-in. stroke; engine develops 175 hp. and has maximum drawbar pull of 12,500 lb.; equipped with cork insert clutch, which runs in bath of light engine oil.

High-Pressure (Schmidt). The Schmidt High-Pressure Locomotive (Die Schmidt-Hochdrucklokomotive), D. R. P. Wagner. V.D.I. Zeit. (Berlin), vol. 72, no. 43, Oct. 27, 1928, pp. 1521–1532, 46 figs. Principles of design and construction details of locomotive with boiler generating steam at two pressures, viz., 60 atmos. and 14 atmos.; high pressure used in central cylinder; exhaust of central cylinder is mixed with 14 atmos. steam, to be used in two outside cylinders.

The Schmidt High-Pressure Locomotive of the German State Railway Company, R. P. Wagner. Am. Soc. Mech. Engrs.—Advance Paper, for mtg. Dec. 3–7, 1928, 9 pp., 11 figs. Details and road-test data of locomotive having boiler which generates steam at two pressures, 850 lb. and 205 lb., using 850 lb. in center cylinder, and its exhaust, mixed with 295 lb. steam, in two outside cylinders.

Oil-Electric. A Powerful Oil-Electric Locomotive for the Long Island Railroad, J. H. Harvey. Tramway and Ry. World (Lond.), vol. 64, no. 14, Sept. 20, 1928, pp. 133–137, 8 figs. Locomotive, of 660 hp. weighing 87 tons, consists of two identical units; Westinghouse-Beardmore light-weight, high-speed, vertical, 6-cylinder engine, using solid injection and operating on 4-stroke cycle; each unit is equipped with two Westinghouse type 308-H motors; maximum locomotive speed of 30 m.p.h. is attained by use of 16.66 gear ratio and 38-in. wheels; maximum tractive effort is 49,500 lb.

Steel Plants Using Oil-Electric Engines. Iron Age, vol. 122, no. 15, Oct. 11, 1928, pp. 895–896, 3 figs. Industrial service follows, experiments by railroads for yard switching; savings in costs; adaptability to industrial plants; oil engine is of vertical, 6-cylinder, 4-cycle, single-acting, variable-speed type, having direct fuel-oil injection.

Steam-Turbine (Ljungström). The Ljungström Turbine Locomotive. Ry. Mech. Engr., vol. 102, no. 10, Oct. 1928, pp. 542–548, 8 figs. Description of Ljungström locomotive built for Argentine State Railways; road tests in Argentine; results of comparative tests with Ljungström-turbine and piston-type locomotive; comparison of turbine locomotives; feature of turbine locomotive in its large starting torque; air preheater; reversing Ljungström locomotive.

Valve Gears (Caprotti). Caprotti Gear Applied to the "President Cleveland." Ry. Mech. Engr., vol. 102, no. 11, Nov. 1928, pp. 615–619, 11 figs. Table showing principal dimensions, weights and proportions of President Cleveland; marked resemblance in lines and finish to British design; description of tests with Caprotti valve gear; brief description of gear; setting gear; checking valve stems for clearance.

M

MACHINE TOOLS

Cost Accounting. Some Important Points in Machine Tool Cost Accounting, A. E. Grover. Am. Mach., vol. 69, no. 20, Nov. 15, 1928, pp. 776–777. Today's market on materials, labor and burden must be used in figuring costs of current sales; cost of maintaining excess capacity not proper charge to operating expense; manufacturing costs divided into material, labor and burden; burden cost of each department divided into buildings, equipment, and general expenses; all general manufacturing expenses distributed direct to production centers. Abstract of paper read before Nat. Machine Tool Bldrs'.

Developments. Present-Day Developments in Machine Tools, E. W. Tipple. Machy. (Lond.), vol. 33, no. 834, Oct. 4, 1928, pp. 9–13 and (discussion) 13–16. Most to be gained by reduction of setting and non-cutting times; forced-feed lubrication to be common; electric-motor drives; Hele-Shaw or Williams-Janney type variable-speed gear and application to broaching machines; flange motor drive; shaft bearings; gearing; gear-box design; modification in structural design; new cutting steels; four methods of hydraulic feed. Paper presented before Assn. Eng. and Shipbldg. Draughtsmen.

MACHINERY

Foundations. Establishment of Machine Foundations (L'établissement des fondations des machines). Pratique des Industries Mécaniques (Paris), vol. 11, no. 7, Oct. 1928, pp. 281–282, 6 figs. Give table of weights which soils will sustain in tons per sq. m.; also concrete and how to lay it and foundation bolt anchorages.

Grease Removal. The Degreasing of Metals. Engineering (Lond.), vol. 126, no. 3275, Oct. 19, 1928, p. 497. Method used in railway repair shops in Germany for degreasing of machinery parts by means of trichlorethylene, was described in May 20, 1927, issue of this journal; firm of A. Wacker, G.m.b.H., of Munich, have placed on market closed rocking metal-cleaning apparatus, and open-dipping equipment, for use in connection with trichlorethylene.

MALLEABLE-IRON CASTINGS

Composition. Effects of various elements on Malleable Iron Castings (Effets de divers éléments sur la fonte malleable), L. E. Gillmore. Fonderie Moderne (Paris), vol. 22, Sept. 25, 1928, pp. 364–365. Describes effects of certain elements such as carbon, phosphorus, manganese, sulphur, and silica, and what elements prevent graphite formation.

MATERIALS HANDLING

Bulk Materials. Bulk-Materials Handling at Docks and Storage Plants, A. F. Case. Materials Handling (A.S.M.E. Trans.), vol. 50, no. 22, May-Aug. 1928, pp. 1–5, 9 figs. Historical review of development of equipment; ideal plant for coal loading consists of mule haulage, revolving car dumper, and loading tower with high-capacity conveyor carried by boom extending over ship's hatch, and telescopic chute to conduct coal into hold; for unloading coal, Hulett unloader or rope operated grab bucket handled by bridge or tower structures are used; paper does not include handling of bulk commodities in small capacities.

Costs. 25 Per Cent Cut in Handling Costs, E. J. Mills. Mfg. Industries, vol. 16, no. 6, Oct. 1928, pp. 441–445, 6 figs. Prompt deliveries of materials rapid flow of work and partial elimination of storerooms brought about by regular internal transportation service in plant of General Electric Co., Pittsfield, Mass.

Grab Buckets. The Polyp Grab. Engineering (Lond.), vol. 126, no. 3274, Oct. 12, 1928, p. 474, 2 figs. Details of grab which can be employed for handling scrap iron, coarse and fine ore, blasted rock, etc., for which ordinary types of grab bucket are not well suited, as well as for excavating and dredging operations; it consists of 8 spade-shaped blades mounted on arms pivoted at their inner ends to central moving head, arms being connected to stationary head by pin-jotted links; made by Reichmann-Becker-Polyp, G.m.b.H., of Duisburg, Germany.

Industrial Plants. Incentive Cut Handling Costs 9 to 50 Per cent, R. E. Jansen. Mfg. Industries, vol. 16, no. 7, Nov. 1928, pp. 525–528, 10 figs. Industrial trucking; preliminary time studies; economy effected; organized plant-transportation service with truckers' wages based on incentive plan brings about substantial reductions in materials-handling costs.

Wage-Payment Plans. Incentives Cut Handling Costs 9 Per Cent to 50 Per Cent, R. E. Jansen. Mfg. Industries, vol. 16, no. 6, Oct. 1928, pp. 415–418, 3 figs. Savings accomplished by Westinghouse Electric and Mfg. Co., by wage plan or materials handling based on standard methods and organized service.

METAL CUTTING

Alinement Charts. Use of Nomograms in Figuring of Metal-Cutting Operations (Anwendung der Nomographie auf die Vorkalkulation beispanabhebender Bearbeitung), F. Hirschfeld and F. Kustin. Maschinenbau (Berlin), vol. 7, no. 18, Sept. 20, 1928, pp. 857–862, 10 figs. Author describes construction and use of alinement charts for figuring speed and time of turning, grinding, milling, etc.

Cold Saws. The Process of Cutting of Metals with Cold Saws (Der Schneidevogang bei der Zerspanung durch Kaltkreissaegen), A. Wallichs and H. Hemscheidt. Maschinenbau (Berlin), vol. 7, no. 20, Oct. 18, 1928, pp. 949–953, 17 figs. General review of evolution of cold circular saw blades, critical discussion of cutting process; effect of cutting angle, clearance angle, and other saw-tooth characteristics on power consumption and efficiency in cutting of various materials.

METALLOGRAPHY

Etching. Smoothing and Etching Cupro-nickel, Bronze, Brass and Steel, H. B. Pulsifer. Am. Inst. of Min. and Met. Engrs.—Technical Paper, no. 137, Oct. 1928, 18 pp., 36 figs. Method for rapid production of flat, granular surfaces on many of medium-hard alloys; accomplished by rubbing on emery papers and on fine abrasives heaped on hand boards; explains advantages of chromic acid in etching; chloric acid is rapid etchant for steel; detailed discussion of various alloys.

METALS

Internal Friction in. Internal Friction in Metals, R. H. Canfield. Phys. Rev., vol. 32, no. 3, Sept. 1928, pp. 520–530, 7 figs. Dissipation of energy by internal friction in metals without history of overstrain or fatigue seems only to accompany shearing stress; pure dilatation is frictionless; severe fatigue increases coefficient of internal friction; this change when due to torsion proceeds to some extent independently of same effect caused by bending (which involves shear stress on planes of different orientation than does torsion), and vice versa.

Plastic Flow. Flow Phenomena under Influence of Pressing and Drawing of Rods and Tubes (Einiges ueber die Fliessbewegung beim Pressen von Stangen und Rohren, sowie beim Ziehen), H. Unckel. Zeit. fuer Metallkunde

(Berlin), vol. 20, no. 9, Sept. 1928, pp. 323–330, 17 figs. Notes on flow phenomena in plastic material in connection with pressing of tubes and of flat rods, and drawing of circular bars; flow movement with pressing of aluminum round bars and tubes and aluminum flat bars.

The Plastic Flow of Metals, W. Lode. Metallurgist (Supp. to Engr., Lond.), Sept. 28, 1928, pp. 133–134. Review of paper published in Forschungsarbeiten auf dem Gebiete des Ingenieurwesen, no. 302, describing series of tests carried out by author; thin-walled tubes were arranged in tensile testing machine in such manner that they could be loaded axially in tension, and at same time subjected to known internal hydraulic pressures; results showed that observations could best be represented by "constant energy of deformation" equation due independently to Huber and von Mises; refers also to paper by G. Sachs in V.D.I. Zeit., June 2, 1928, analyzing results of Lode's work.

The Plastic Flow of Metals, W. Lode. Metal Stampings, vol. 1, no. 6, Nov. 1928, pp. 442 and 450. Description of tests conducted by author to assess limiting values of stresses that may be permitted in material subjected to various kinds of compound loading. Translated abstract of article previously indexed from V.D.I. Zeit., June 2, 1928.

Pressing and Forming. Press Working and Forming of Metals, E. V. Crane. Metal Stampings, vol. 1, no. 5, Oct. 1928, pp. 353–356 and 360, 6 figs. Author continues discussion of typical shearing operations performed on presses; compound blanking and punching; blanking and repunching.

Testing. Statics of Failure by Repeated Stress (Statische Grundlagen zum Schwingungsbruch), W. Kuntze. V.D.I. Zeit. (Berlin), vol. 72, no. 42, Oct. 20, 1928, pp. 1488–1492, 8 figs. Report from government testing laboratory of Dahlem, near Berlin, on experimental study of deformation phenomena and decrease in tensile strength of silicon steel, duralumin, copper, brass, etc.

MILLING MACHINES

Screw-Thread. Notes on Thread Milling (Bemerkungen ueber Fraesen von Gewinden), N. N. Sawin. Maschinenbau (Berlin), vol. 7, no. 20, Oct. 18, 1928, pp. 973–975, 7 figs. Study of characteristics of thread millers; tables and charts for correct selection of feeds and speeds.

MOTOR BUSES

Six-Wheel. Tilling-Stevens Petrol-Electric Six-Wheel Omnibus. Tramway and Ry. World (Lond.), vol. 64, no. 19, Oct. 18, 1928, pp. 237–239, 7 figs. Vehicle with full load of 66 passengers, weighs under 12 tons; capable of speed of 45 m.p.h.; engine rated at 36.15 hp.; four-cylinder, 4¾-in. bore and 6-in. stroke; two rear axles are mounted by means of special arrangement of separate semi-elliptical springs, each of which is mounted on bell-crank levers at rear end and frame brackets at front end; back axles are of underslung-worm type with bevel gear differentials and fully floating axle shifts.

O

OIL FUEL

Calorific-Value Determination. The Determination of the Calorific Value of Diesel Oil, F. V. Warnock. Engineering (Lond.), vol. 126, no. 3273, Oct. 5, 1928, pp. 418–419. Tabulated results of experiments on determination of calorific value of Diesel oil, using Darling's calorimeter, are presented.

Ignition. Auto-Ignition Temperatures of Liquid Fuels, O. C. Bridgeman and C. F. Marvin, Jr. Indus. and Eng. Chem., vol. 20, no. 11, Nov. 1928, pp. 1219–1223, 2 figs. Review of published data concerning effects of certain factors on experimentally determined ignition temperatures, together with brief description of preliminary measurements made at Bureau of Standards by bomb method; analysis from point of view of phenomena involved in ignition process; significance and application of ignition temperatures are discussed. Bibliography.

OPEN-HEARTH FURNACES

Handling Problems. Handling Problems in the Open-Hearth, J. Richardson. Blast Furnace and Steel Plant, vol. 16, no. 10, Oct. 1928, pp. 1326–1328, 3 figs. Each plant requires special study in making improvements in methods employed in moving materials; list is given of materials involved in regular course of operations, for reference to chief handling problems; stock-yard problems, ferroalloys and refractories; broad field for constructive planning.

Tilting. Why Tilting Furnaces Are Better, C. W. Peirce. Iron Age, vol. 122, no. 12, Sept. 20, 1928, pp. 693–694. Different points of superiority of tilting furnace which aid in working open-hearth heat and avoid many troubles; likely to make better steel; ability to remove unsatisfactory slag; tilting furnace does away with slow and hard taps; less danger of breakouts in fronts and ends; less bottom trouble and greater tonnage.

OXYACETYLENE CUTTING

Mechanical Control. Advantages of Mechanical Cutting. Acetylene Jl., vol. 30, no. 4, Oct. 1, 1928, pp. 145–146, 5 figs. Economies accomplished by mechanical control of oxy-acetylene cutting torch, through elimination of other operations, usually exceed more obvious savings in gas and labor; type of machine which is made for operations suggested is Radograph, which is shown; machine-cutting torch makes remarkable showing from viewpoint of economy and quality of product; economy of gas and time which is accomplished by uniformity of control of operation.

OXYACETYLENE WELDING

Butt Joints. Tests of Acetylene-Welded Butt Joints (Beobachtungen an acetylegeschweissten Stumpfstossnaehten), H. Holler. Autogene Metallbearbeitung (Halle), vol. 21, no. 18, Sept. 15, 1928, pp. 252–270, 43 figs. Experimental study of speed of welding, length of welds and gap between welded parts; empirical formulas for speed of welding in terms of thickness of plates.

P

PENSTOCKS

Welded Steel, Testing. Weld Efficiency in Penstock Pipe Using Overlap Welds, O. Reed. Eng. News-Rec., vol. 101, no. 15, Oct. 11, 1928, pp. 550–552, 2 figs. Average of many tests shows welds exceeding 90 per cent of plate strength for plate thicknesses of 0.4 to 1.3 in.; data on actual tests of 522 welded pipe sections, for Balch penstock manufactured by Ferrum Co. in Poland, for San Joaquin Light & Power Corp., Fresno, Calif.; variation of weld strength with plate thickness.

PIPE, CAST-IRON

Centrifugal Casting of. Improved Process for Casting Pipe Centrifugally in Green Sand Molds, G. Guerrini. Foundry, vol. 56, no. 20, Oct. 15, 1928, pp. 832–835, 21 figs. Method developed by Possenti and Scorza and in use at Foundry Works of Montecatini Co., Pesaro, Italy is described; equipment comprises compressed-air molding machine, upon which one or four special flasks are placed to form molds; Italian sand used; runner through which metal is poured; possible to make pipe of various diameters and of different lengths; micrographs shown and discussed. See also Iron Trade Review, vol. 83, no. 16, Oct. 18, 1928, pp. 993–996.

Power-Factor Improvement. Maintaining High Power Factor in an Industrial Plant, F. A. Westbrook. Power Plant Eng., vol. 32, no. 22, Nov. 15, 1928, pp. 1196–1197, 3 figs. Description of new equipment installation at Hay Foundry and Iron Works, Newark, N. J., where measures have been taken to correct plant-power factor; power is brought in from street line at 4150 volts, 3-phase, 60-cycle; because of new type of electric drill and reamer designed not to stall and requiring 180-cycle current, frequency changer is necessary, consisting of 30-hp., 440-volt, 3-phase induction motor which drives 180-cycle, 3-phase generator of corresponding capacity.

POWER PLANTS

Coal Handling in. Boiler Coaling Plants. Mech. World (Lond.), vol. 84, nos. 2176 and 2179, Sept. 14 and Oct. 5, 1928, pp. 243–245 and 315–317, 8 figs. Sept 14: Design of elevator feed shoot, boot, head, and chains is discussed; attachment of buckets, skids, pushplates and rollers. Oct. 5: Driving gears, overload throwout, and top-deck isolating switch are described; push-plate conveyor has low initial cost and requires little power; few small coaling plants briefly described.

POWER PLANTS, DIESEL

Ipswich, Mass. Diesels Solve the Power Problem of Ipswich, Mass., G. Grow. Power, vol. 68, no. 17, Oct. 23, 1928, pp. 679–680, 3 figs. Study of figures revealed that total reduction in operating expense would amount to about $5000 per year if Diesel engines were installed, while increase in investment would be $13,000 above cost of steam equipment; two 300-hp. units occupy small floor space and are placed in same room with old steam engine; one interesting feature is use of spiral-riveted pipe for engine exhaust stacks.

Tucson, Ariz. Tucson Utility adds 7500-hp. Diesels, O. H. Barnhill. Oil Engine Power, vol. 6, no. 10, Oct. 1928, pp. 664–668, 5 figs. Operating costs for 1927; Busch-Sulzer 3750-b.hp. Diesel recently added has fuel consumption of 0.42 lb. per b.hp-hr.; fuel oil is stored in three 275,000-gal. steel tanks; cooling water is drawn through 120-ft. suction pipe from 600-ft. well with Byron-Jackson 1000-g.p.m. pump; water is cooled by being sprayed over shallow concrete tank 50 by 100 ft.

POWER PLANTS, HYDROELECTRIC

Conowingo, Md. Conowingo Power Plant, Susquehanna River. Cornell Civ. Engr., vol. 37, no. 1, Oct. 1928, pp. 5–8, 24–25 and 32. Plant construction; general description; power station will have rating of 378,000 hp. with its initial installation of seven units; generator room and headworks; description of dam; power station construction.

Flow Meters for. Flow Measuring Devices for Hydroelectric Plants. Power Plant Eng., vol. 32, no. 20, Oct. 15, 1928, pp. 1102–1104, 4 figs. New England Power Co. employs various flow-measuring devices, all of which utilize pressure differentials developed by existing features of station design; devices installed in different stations are described. From report of Nat. Elec. Light Assn., Hydraulic Power Committee.

POWER PLANTS, STEAM-ELECTRIC

Design. Design Studies for Gould Street Generating Station, F. T. Leilich, C. L. Follmer and R. C. Dannettel. Am. Inst. Elec. Engrs.—Jl., vol. 47, no. 10, Oct. 1928, pp. 748–752, 5 figs. Developments in central-station art have been so rapid within last few years that many of recent outstanding stations differ considerably in major elements of design; authors briefly outline high points of analyses upon which principal features of Gould Street station design in Baltimore were based.

Peak-Load Problems. The Peak-Load Problems in Steam Power Stations, A. G. Christie. Am. Soc. Mech. Engrs.—Advance Paper, for mtg. Dec. 3–7, 1928, 9 pp. 14 figs. Paper deals with use of load-duration curve for purpose of studying annual peak loads; conclusions are drawn that plant intended for annual-peak-load service should only be installed at lowest possible first cost, and that economy of peak-load equipment can be sacrificed to secure low initial cost.

Saginaw, Mich. New Unit Adds 30,000 Kw. to Saginaw River, J. W. L. Harris. Power Plant Eng., vol. 32, no. 20, Oct. 15, 1928, pp. 1098–1101, 5 figs. Details of new unit of plant of Consumers Power Co., near Saginaw, Mich.; underfeed stokers are used; for four new boilers, stokers have 12 retorts, 45 tuyeres with double 18-in. roller crushers and projected grate area of 385.3 sq. ft.; furnace volume is 6000 ft.; stokers are driven by motors with 300, 600, and 1200 r.p.m. windings, connected to controller which varies speed between 300 and 1200 r.p.m., river water used for condensing; there are three independent sources of supply.

PUMPS, CENTRIFUGAL

Design. Centrifugal Pumps, E. W. Sargeant. Mech. World (Lond.), vol. 84, nos. 2175 and 2178, Sept. 7 and 28, 1928, pp. 224–226 and 294–296, 9 figs. Sept. 7: Considerations of speed in designing centrifugal pumps; plenum and vacuum systems of charging; history of series of multiple-effect centrifugal pump. Sept. 28: Mine pumps described; series pump for providing heavy hydraulic pressure for working cranes; electrically driven double series pump; remedies for failure to start pumping or loss of water; foot valves should be avoided; three testing methods.

R

RAILWAY MOTOR CARS

Diesel. The New Light-Metal Diesel Railroad Motor Car of the Halberstadt-Blankenburg Railroad (Ein neuer Leichtmetall-Diesel-Triebwagen mit mechanischer Kraftuebertragung bei der Halberstadt-Blankenburger Eisenbahn), E. H. Steinhoff and D. K. Kettler. Verkehrstechnik (Berlin), no. 38a, Sept. 21, 1928, pp. 700–706, 13 figs. Design and construction of rapid-transit cars, 11.8 m. long, weighing 10 tons, driven by M.A.N. Diesel engine, with mechanical

transmission; use of such cars in mountainous regions results in economy of 35 per cent.

Diesel-Electric. Diesel-Electric Rail Car for the Pamplona-San Sebastian Railway. Engineering (Lond.), vol. 126, no. 3275, Oct. 19, 1928, pp. 497–499, 6 figs. Car is 49 ft. 3½-in. over buffers, and has two 4-wheel trucks; engine is capable of developing 200 b.hp., which is transmitted electrically to geared driving motor on each axle; accommodation is provided for 32 passengers; engine is 6-cylinder 4-cycle, simple fluid-pressure injection type.

Germany. Recent Types of Railroad Motor Cars (Neuere Oeltriebwagen), G. Naske. V.D.I. Zeit. (Berlin), vol. 72, no. 44, Nov. 3, 1928, pp. 1605–1612, 25 figs. Details of internal-combustion engines, transmission gear, and other parts of two-axle and four-axle railroad motor cars, up to 200 hp., developed jointly by Allgemeine Elektrizitaets Gesellschaft and Deutsche Werke, Kiel.

REFRIGERATING MACHINES

Carbon Dioxide. Graphical Method for Finding the Most Favorable Condensing Pressure in Carbon Dioxide Refrigerating Machines (Zeichnerisches Verfahren zum Auffinden des guenstigsten Kondensatordruckes in Kohlensaeure-Kaeltemaschinen), H. Inokuty. Zeit. fuer die gesamte Kaelte-Industrie (Berlin), vol. 35, no. 9, Sept. 1928, pp. 180–182, 2 figs. Abstract of paper read at Fifth International Refrigeration Congress of Rome on method of construction and use of charts for computing optimum condensing pressures.

ROLLING MILLS

Blooming Mills, Electric Equipment of. Specification for 40 in. Reversing Blooming Mill Drive. Iron and Steel Engr., vol. 5, no. 10, Oct. 1928, pp. 448–451. Specification covers electrical apparatus to drive two-high reversing mill, having 40-in. pitch diameter rolls; equipment is to consist of reversing d.c. roll drive motor, receiving its power from suitable motor-generator-flywheel set and complete control equipment for same.

Efficiency. Figuring Efficiency of Steel Mills, F. C. Smith. Iron and Steel of Canada (Gardenvale, Que.), vol. 11, no. 10, Oct. 1928, pp. 300–301. Method of calculating for rolling; allowing for lost time, cobbles, changing sections; problem is that of comparing relative efficiency of different mills and of performances of same mill at different times; practical method is to compare actual production with theoretical maximum. Abstracted from Iron Age.

S

SAWS

Woodworking. Reducing Waste by Improvement of Design and Use of Woodworking Saws and Knives. Am. Soc. Mech. Engrs.—Advance Paper, for mtg. Dec. 3 to 7, 1928, 8 pp., 25 figs. Reasons for standardization; primary, secondary, power, and total savings; theory of cutting wood with saws and knives; general and specific classifications of saws; saws for primary conversion of logs into timber and lumber; saws for re-manufacturing; general classification of knives and cutters; planer and jointer, and shaper knives and cutters; initial cost of research.

SCREW THREADS

Dardelet Type. The Dardelet Screw Thread. Am. Mach., vol. 69, no. 20, Nov. 15, 1928, p. 755. Problem of designing bolt from which nut will not rattle loose and brief description of principle involved in design of Dardelet screw threads now becoming popular in France and Belgium; Bureau of Standards research.

STEAM

Critical Point. The Callendar Equations and the Critical State of Steam. Engineer (Lond.), vol. 146, no. 3795, Oct. 5, 1928, p. 378. Editorial remarks, based on paper by Callendar presented before Roy. Soc., on steam tables and equations extended by direct experiment 4000 lb. per sq. in. and 400 deg. cent.

STEAM CONDENSERS

Performance. 10,000-kw. Turbo-Generator and Condenser at Stonebridge Park Power Station. Engineering (Lond.), vol. 126, no. 3273, Oct. 5, 1928, pp. 419–423, 14 figs. Generator develops 12,500 kw. at maximum rating and at 0.9 power factor; it supplies 3-phase, 50-cycle current at potential of 11,000 volts, and is provided with closed-circuit system of air cooling; condensing plant like turbo-generator, has been subject of exceptionally thorough and comprehensive test; power station provides current required for working metropolitan electrified suburban service of London, Midland and Scottish Railway Co. analysis of condenser performance.

Tubes, Chromium-Iron. Advantages and Limitations of Chrome-Irons for Condenser Tubes, F. C. Lea. Iron Age, vol. 122, no. 15, Oct. 11, 1928, p. 894. Tests of action of tubes of steam superheaters under severe working conditions; nickel-chromium-iron alloy, chromium-iron alloy and mild carbon steel are studied. Abstract of paper presented before Brit. Assn. for Advancement of Science.

STEAM METERS

"Turbine." The "Turbine" Steam Meter, J. M. Hodgson. Instruments, vol. 1, no. 10, Oct. 1928, pp. 435–438, 3 figs. Successful and accurate meters on turbine principle for bulk measurement of air, gas, and steam; meter is designed to stand considerable overloads; measurement of pulsating flows; maintenance of meter; applications; flow that can be metered.

STEAM PIPE LINES

Design. Design of Steam Piping to Care for Expansion, W. H. Shipman. Am. Soc. Mech. Engrs.—Advance Paper, for mtg. Dec. 3 to 7, 1928, 21 pp., 22 figs. Author arrives at fundamental principles of design; presents complete mathematical theory of piping subjected to expansion; reduces very complicated results to simple, usable basis; survey of published work.

Expansion Fatigue. Experimental Researches on Expansion Fatigue in Steam Pipe Lines (Recherches expérimentales sur la fatigue à la dilatation des tuyautages de vapeur), R. Thery. Bul. Technique du Bureau Veritas (Paris), vol. 10, no. 9, Sept. 1928, pp. 178–181, 4 figs. Outlines Marbec method of calculating fatigue and that of Le Besnerais; tests made to determine which method is more accurate; arrangement of testing apparatus and results of tests.

STEAM TURBINES

Van den Bossche. Calculation of the Van den Bossche Turbine (Calcul de la turbine Van den Bossche), J. Van den Bossche. Chaleur et Industrie (Paris), vol. 9, no. 101, Sept. 1928, pp. 502–506, 2 figs. Discusses theory of turbine calculation and application to tests made in Fully power plant; author's turbine operates on constant volume, without intervention of external cold source; he compares his system with principle of hydraulic turbine where heating of liquids in blades diminishes in proportion to transformation of kinetic energy in motor work.

STEEL

Alloy. See ALLOY STEELS.

Chromium-Aluminum. See CHROMIUM-ALUMINUM STEEL.

Cold-Drawn, Testing. The Change in Tensile Strength Due to Aging of Cold-Drawn Iron and Steel, L. B. Pfeil. Engineering (Lond.), vol. 126, no. 3273, Oct. 5, 1928, pp. 439–441, 2 figs. Experimental work described consisted of cold drawing without annealing of series of steel of varying carbon content, and also of varying heat treatment, followed in all cases by tensile tests at different stages of reduction and at different lengths of time after drawing; increase in tensile strength due to aging amounts on average to 2.32 tons per sq. in. Abstract of paper presented before Iron and Steel Inst.

Heat Treatment, Quenching Oils for. Oils to Use for all Heat Treatment Purposes, H. L. Kauffman. Mill and Factory Illustrated, vol. 2, no. 3, Oct. 1928, pp. 33–35, 6 figs. Such terms as heat treatment, quenching, hardening, annealing, tempering are defined and specific oils for fuel and quenching are recommended for each heat-treatment process.

High-Speed. See HIGH-SPEED STEEL.

Tool. See TOOL STEEL.

STOKERS

Traveling-Grate. Firing of Furnace Residue on a Mechanical-Feed Grate in German Government Railroad Repair Shop at Offenburg (Verbrennung von Rauchkammerloesche auf einem Vorschubtreppenrost im Reichsbahnausbesserungswerk offenburg), Stadtmueller. Waerme (Berlin), vol. 51, no. 39, Sept. 29, 1928, pp. 709–711. Details of design and operation of Seyboth grate; evaporation tests with use of different mixtures of coal and residue; recommendations for altering Seyboth grate for combustion of residue with addition of coal.

Methods of Tempering Coal for Traveling-Grate Stokers, K. W. Hayward. Power, vol. 68, no. 19, Nov. 6, 1928, p. 746. One of best ways to temper coal is to submerge it in water for sufficient length of time to allow moisture to soak through it thoroughly; method can be used only where submerged storage system or submerged conveying system is available; substitution for adding of water to coal is use of exhaust steam in stoker hoppers.

T

TOLERANCES

Skoda vs. D.I.N. System. Comparison of Tolerance Systems Used in Germany (D.I.N.) and at the Skoda Works (Czechoslovakia) [Comparaison des systèmes de tolérances employés en Allemagne (D.I.N.) et aux usines Skoda (Techéco-Slovaquie)], Schlesinger. Génie Civil (Paris), vol. 93, no. 13, Sept. 29, 1928, pp. 301–304, 7 figs. Review of Skoda tolerance system and comparison of its features with those of other systems in use in Germany; classification of tolerances.

German and Skoda Tolerances Compared, G. Schlesinger. Am. Mach., vol. 69, no. 19, Nov. 8, 1928, pp. 725–730, 9 figs. Article by N. N. Sawin, previously printed on page 721, vol. 67, of this magazine, claiming that German system did not prove satisfactory in Skoda works, Czechoslovakia, is refuted by author; extensive investigation of experiences of leading German concerns shows that German tolerance system meets all of requirements of practice; ball and roller-bearing practice.

TOOL STEEL

Heat Treatment. An Up-to-the-Minute Tool Hardening Department, A. H. d'Arcambal. Mill and Factory Illustrated, vol. 2, no. 3, Oct. 1928, pp. 25–28, 8 figs. Heat-treating department of Pratt and Whitney Co. is described covering equipment and methods of operation.

TRAIN CONTROL

Automatic. Automatic Train Control Installation and Maintenance. Ry. Mech. Engr., vol. 102, no. 10, Oct. 1928, pp. 569–571. Roads install and maintain device that will automatically apply brakes, bringing train to stop when approaching occupied or restricted block; progress of installations as of July 1928; train-control characteristics; signal indications in cab; methods of restricting train speed

W

WELDING

Electric. See ELECTRIC WELDING, ARC.

Oxyacetylene. See OXYACETYLENE WELDING.

Steel Construction. Electric Welding in Steel Construction (Das elektrische Schweissen im Eisenbau), S. Bryia. Zeit. des Oesterr. Ingenieur und Architekten-Vereines (Vienna), vol. 80, no. 37–38, Sept. 21, 1928, pp. 328–333, 10 figs. General review of progress in welding of steel structures; results of experimental studies; design of welded joints; comparative strength and cost of welded and riveted joints; types of welded joints used in buildings, bridges, reinforced-concrete structures, etc.

Structures, Stresses in. Maximum Allowable Working Fiber Stresses in Welded Structures, S. W. Miller. Am. Welding Soc.—Jl., vol. 7, no. 9, Sept. 1928, pp. 21–27. Considers case of mild steel of ultimate strength of 55,000 lb. per sq. in. having yield point of 35,000 lb. per sq. in.; properly made bend test is found to show much more closely actual ductility of weld metal; no theoretical basis for working fiber stress; necessary at present to depend on practical results for development of any formula that would be used for purpose; proposed maximum allowable working fiber stresses in lb. per sq. in. of plate section for welded-steel pressure vessels.

WOODWORKING MACHINERY

Ball Bearings. Ball Bearings Increase Machine Efficiency, A. W. Williams. Wood-Worker, vol. 47, no. 8, Oct. 1928, pp. 36–37, 3 figs. Reviews experience of superintendent of large box factory, with ball-bearing machines; people whose experiences are dealt with were pioneers in matter of equipping boxmaking machinery with ball bearings.

Engineering Library

DEC 29 1928

Progress

News of Mechanical Engineering

What It's All About!

DO YOUR friends know what engineers do and think about? Do you want the high lights of your profession? The story told in this supplement summarizes the contents of the January issue of MECHANICAL ENGINEERING. After you have read it, pass it on to your friends.

"The Hobgoblin of Little Minds"

MR. ALEX DOW, in his A.S.M.E. presidential address, "a deliverance ex cathedra, wise in content and literary in form," rushed to the rescue of a good word which suffers from indiscriminate use and leads to cloudy thinking. Mr. Dow likes strong words; he dislikes to see them prostituted. He has seen "efficiency" and "welfare" go wrong; he is fearful that "research" is headed down the path of misuse; and he is worried about "consistency," which a poet characterized as a jewel, a foolish variety of which a sage designated as a "hobgoblin of little minds," and Mr. Dow himself praises as a truly valuable quality. Mr. Dow concludes that consistency, or unity of aim, is an evidence of the superiority of man over other creatures, is inborn, does not conflict with usefulness. His address, sometimes serious, sometimes whimsical, and always interesting, is the leading article in this month's MECHANICAL ENGINEERING.

Engineering Progress

EVERY year the A.S.M.E. Professional Divisions report the progress of the year. These fourteen progress reports form the major portion of January MECHANICAL ENGINEERING.

Aeronautics. Seven national authorities sum up the year's progress in aeronautics. The layman will read with surprise that there are at least 50 different aircraft engines below 300 hp. in various stages of development, and that most of them weigh less than 4 lb. per horsepower. Small engines cost about $25 and large ones $15 per horsepower. Engineers will herald the development of a Diesel engine weighing 3 lb. per horsepower, and the record made by a plane equipped with a supercharger which climbed to an altitude of 20,000 ft. in 11 minutes. Industrialists and business men will be convinced of the commercial importance of the airplane in learning that the air-transport mileage in the United States was about 6 million miles last year.

Railroads. Better utilization of existing equipment, longer engine runs, and improved maintenance have resulted in greater operating economies on the railroads, but have reduced the demands for new equipment to an unprecedentedly low figure. Increase in locomotive power by using bigger boilers and boosters has made it possible to maintain existing schedules with heavier loads. Alloy steels, more high-pressure and three-cylinder locomotives, the extensive use of roller bearings in passenger cars and experiments with similar bearings in freight cars, and labor-saving machinery replacing gang labor in maintenance-of-way work are duly noted. Railroad executives have felt the competition of motor truck, motor bus, and airplane.

Machine-Shop Practice. New cutting alloys, capable of removing in a given time greater amounts of metal than is customary with present tools, indicate that within a few years present-day metal-working machines will be obsolete so far as their capacity, relative to the capacity of the cutting tool, is concerned, and that the production policy from now on should be one of getting the most out of existing equipment. Thus the report on machine-shop practice records a recent development and points the way to an intelligent anticipation of possible consequences. The arts of welding and brazing have definitely advanced. Plating, grinding, heat-treating, machine finishes, the use of a multiple V-belt drive, and new forging methods are elements of progress.

Industrial Management. Through the maze of modern industry with its "profitless prosperity" and rapidly shifting problems, the engineering principles of standardization and waste elimination are making steady progress. One concern universally considered as efficient reports the return in 1928 in profits of fourfold the amounts spent in the preceding three years on a program of standardization of materials and parts; another reports annual savings of $50,000 in materials, and a third total annual savings of $260,000 from concrete ideas suggested by employees. Budgeting and management ratios have increased thought during the past year as fact-finding and measuring agencies in the solution of modern industrial problems. Obsolescence of equipment is one of the important management problems that is getting the increased attention it deserves.

Materials Handling. Industrial philosophers continue to note with satisfaction the contributions of materials-handling engineers to the economics of production. Among the many interesting developments of the year are the transfer by crane from dock to ship of fully loaded refrigerator cars at New Orleans and Havana docks; automatic grabs, practically eliminating the use of men on the cable-storage and testing floor of the Hawthorne plant of the Western Electric Company; die-handling trucks of 12 and 14 tons capacity; a 6000-lb. high-lift truck with a range of 11 ft. 6 in. General trends in materials-handling equipment include the use of pressed-steel and welded construction; the introduction of roller bearings; better drives and lubrication; larger capacities; and improved controls.

Oil and Gas Power. Radical changes in merchant shipping are prophesied with the adoption of the oil engine. In the year ending March, 1928, motor horsepower installed in new ships was one and two-thirds that of steam. Notable innovations in marine work include the installation of Diesel engines in war vessels for operating in the cruising range and the use of speed-reduction gears by which two engines are connected to the same propeller shaft. On the railroads 36 oil-engine locomotives totaling 10,000 hp. are in service. In aeronautics the important development was the 200-hp. 9-cylinder, radial, air-cooled airless-injection Diesel flown in a monoplane in September, 1928. A coal-dust engine also aroused interest.

Hydraulics. The present trend in water power is toward its economical use in connection with steam power. Recent advances in economy of steam-power plants make it difficult to justify a hydro development in comparison with steam power. As the efficiency of the hydro plant has just about reached its theoretical maximum, competition with steam stations cannot be met in this manner and recourse must be had to lowering investment costs and to making the most of its inherent advantages. There is no cause for pessimism as to the future of water-power development, however as necessity is a good stimulant.

Steam Power. Much intensive work in the consolidation of gains incident to past progress and the raising of the average standard of steam-station design and operation were witnessed during 1928. It is possible, assuming favorable conditions, to produce power by using the straight steam cycle with 12,500 B.t.u. per kilowatt-hour of net send-out, and assuming the same favorable conditions, to produce power with from 11,000 to 10,000 B.t.u. per kilowatt-hour of net send-out by

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using the mercury-vapor-steam cycle. All of the equipment and knowledge required for the assembly of this equipment and for its operation are available to permit the building of highly efficient generating stations from 1,000,000 kw. down to 1000 kw.

Printing Industries. Marked examples of recent development show increased production of at least two-thirds over an average of earlier but comparatively modern presses. Paper now runs through newspaper presses at the rate of 26 ft. per sec., giving a production at the rate of 50,000 32-page papers per hour. A recent Sunday edition of 400,000 240-page papers required 1200 rolls of paper weighing 1200 lb. each. These figures indicate that aside from any technical problem in the design and operation of improved machinery, the printing-plant engineer has also a materials-handling problem of no small importance. Technical features of the year's advance are replacement of iron by steel in frames, helically cut gears, anti-friction bearings, and automatic lubrication.

Iron and Steel. Delivery during 1928 of 59 million tons of iron ore to blast furnaces and steel plants required the extensive use of mechanical handling and mining apparatus which increases in amount, variety, and capacity from year to year. Developments in rolling mills include the construction of new mills of large size, of continuous rolling, of a plant for rolling tin plate so thin that it can be torn between the fingers, a new piercing mill for the seamless-tube industry with a capacity up to 15 in. outside diameter, and the extended application of anti-friction bearings. As for the steel plants, they are, paradoxically, running full when operating at 75 to 80 per cent of capacity.

Textile Industry. The most radical and best advance in the textile industry during the past year is the changed mental attitude of many leaders as to the industry in general, and their own businesses in particular, in realizing that the old methods of financing, selling, and manufacturing which built up the industry are not infallible, are not adequate today, and that better ways may exist. Such an attitude augurs well for technical as well as commercial improvement. Of the major branches of the industry, rayon and woven felt have experienced the greatest advances.

Wood Industries. Business men will note with interest that there has been a steady increase in the use of dimension stock, that the practice of packaging is increasing, that there are dangers of exhaustion of wood supplies, and that there is a menace to the industry in the use of substitutes. Engineers will note with approval use of individual motor drive, standardization of power requirements, increased use of formed cutters and knives, substitution of high-speed tungsten steel for carbon-steel cutters, compressed air for driving small tools, portable electric screwdrivers, drills and saws. Application of engineering principles to the ancient art of woodworking is making steady progress.

Petroleum Industry. Throughout the petroleum industry during the past twelve months the overproduction in crude oil and the resultant reduction in selling price of finished product have reduced waste in production, handling, and refining. This condition ceases to appear paradoxical when it is remembered that waste is not intentional, but the result of continuance of obsolete methods when new ones are known and applicable. Such improved methods are necessary to companies wishing to stay in business without loss when the overall margins of profit are least. Overproduction thus serves to spur engineering progress, and the improvements of the past year are the results of efforts to find the most economical solution of the problems of a highly competitive industry.

Fuels Utilization. That the country is not utilizing all of the coal which the industry is organized to produce and that oil and natural gas resources, in spite of fears for their extinction, are still discovered and put to use, are brought out in the report on progress in fuels utilization. In equipment are noted the increased use of furnaces with water- and steam-cooled walls, adoption of automatic combustion control, strengthening of stoker parts and increase in length and width, greater use of pulverized coal, and an increase in the use of the unit-pulverizer system. The research activities of the field have been adequately covered in papers before the three great meetings of the year; that of the A.S.M.E. Fuels Division, in Cleveland, the Fuels Conference of the World Power Conference, in London, and the Second International Conference on Bituminous Coal, in Pittsburgh.

A Glance at the "Survey"

Advances Recorded in This Department of January "Mechanical Engineering"

PRECOMPRESSION-chamber-Diesel engine is developed in Germany, in which initial combustion taking place in an excess of air blows the chamber clean so that the main combustion takes place under the influence of the turbulence thus produced with further injection of fuel into the working cylinder. . . . A biplane with movable wings which, it is claimed, can neither stall nor nose dive, has been designed in California. . . By using alkaline hydrates as catalyzers, it is possible to hydrogenate pitch without diminishing the activity of the catalyst. . . . A single-sleeve-valve internal-combustion engine has been shown by tests to be practicable. . . . A radial aircraft Diesel engine is reported to have a sustained output of 200 hp. for 600 lb. of weight. . . . A powdered-coal Diesel engine is said to have possibility of producing power at a fuel cost below that of a large central station operated with high-pressure steam. . . . A saving of 15 per cent over hand-firing is reported for the British steamship *Stuartstar*, which used powdered coal under her boilers during a voyage between London and Buenos Aires. . . A micrometer has been developed for measuring the thickness of varnish films. . . . Crankshaft vibration is counteracted at an early stage by means of an oscillating vibration damper developed by an automobile company. . . . Operation of motor cars by means of a gas producer supplied with pulverized coal is analyzed by an English author. . . . Efficiency of 87.5 per cent is reported in the operation of a paper company's boiler plant equipped with an automatic coal-pulverizing plant. . . . Tests show that steam-turbine blades carefully socketed develop nearly the full fatigue strength of the material from which they are made. . . . Improvements are noted in the new 1200-hp. Diesel locomotive for the Russian Railways Administration. . . . Bullet-proof glass is used to safeguard workmen from bits of steel flying from broken hubs in a cold-hubbing hydraulic press. . . . A high-speed strip rolling mill for light-gage brass up to 7 in. wide has been designed in England to operate at a rolling speed of 250 ft. per min. and a reduction per pass of from 40 to 45 per cent of the thickness after annealing.